O 37: Poster Session III: Surface magnetism III

Time: Tuesday 10:30–12:30 Location: P

O 37.1 Tue 10:30 P

Exchange bias in Co/CoO(110) bilayers — •Tomasz Blachowicz[1] and Andrea Ehrmann[2] — [1]Silesian University of Technology, Institute of Physics - Centre for Science and Education, Gliwice, Poland — [2]Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, Bielefeld, Germany

Co/CoO is a ferromagnet/antiferromagnet system in which the exchange bias, a unidirectional anisotropy, was discovered [1]. The exchange bias can be accompanied by another anisotropy, the so-called 90° coupling, resulting in a rotation of hard and easy axes of the ferromagnet (FM) due to coupling to the antiferromagnet (AFM) at low temperatures [2]. Here we report on exchange bias and 90° coupling in Co/CoO(110) thin film systems, resulting not only in a rotation of the easy axes of the FM below the blocking temperature, but also in a significant increase of the coercive fields near the blocking temperature for one sample orientation. Combining Brillouin light scattering (BLS) and superconducting quantum interference device (SQUID) measurements, we show the temperature-dependent effect of the different superposed anisotropies.

[1] T. Blachowicz, A. Ehrmann: Exchange bias in thin films - an update, Coatings 11, 122 (2021)

[2] T. Błachowicz, A. Tillmanns, M. Fraune, B. Beschoten, and G. Güntherodt: Exchange-bias in (110)-oriented CoO/Co bilayers with different magnetocrystalline anisotropies, Phys. Rev. B 75, 054425 (2007)

O 37.2 Tue 10:30 P

Wavelength-dependent magnetization dynamics in Ni|Au bilayers — •Christopher Seibel, Marius Weber, Sebastian T. Weber, Hans Christian Schneider, and Baerbel Rethfeld — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Kaiserslautern, Germany

Existing experimental and theoretical studies of ultrafast demagnetization in ferromagnets rely mostly on only one fixed wavelength to excite the sample. However, recent experiments indicate that the dynamics of the demagnetization and remagnetization process depend on the wavelength of the exciting laser pulse [1, 2].

In this contribution, we apply the temperature-based μT-model to investigate the magnetization dynamics of a thin nickel layer on a gold substrate. Our model relies on realistic densities of states of both materials and includes energy and spin transfer at the interface. Additionally, we focus on the absorption of the exciting laser by calculating a spatially resolved absorption profile of the sample. We show the influence of wavelength-dependent excitation on the magnetization dynamics based on the energy deposition and energy transfer in the layers.

References:
[1] V. Cardin *et al.*, Phys. Rev. B 101, 054430 (2020)
[2] U. Bierbrauer *et al.*, JOP: Cond. Mat. 29, 244002 (2017)

O 37.3 Tue 10:30 P

Ultrafast demagnetization dynamics including spin resolved charge and heat transport. — •Sanjay Ashok, Sebastian T. Weber, Christopher Seibel, Johan Briones, and Bärbel Rethfeld — Fachbereich Physik and OPTIMAS Research Center, TU Kaiserslautern, Kaiserslautern, Germany

Ultrafast Demagnetization of metallic ferromagnets due to excitation with a femtosecond laser pulse was discovered by Beaurepaire et al. in 1996 [1]. In case of metallic magnets with thickness lesser than penetration depth of the laser, the film is heated homogeneously. Therefore, due to absence of temperature and density gradients within the material there would be no heat- or charge-currents. For thicker magnetic metals, the heating is not uniform and therefore one needs to distinguish the resulting role of heat and spin-resolved charge transport in ultrafast de- and re- magnetization [2]. This is a pivotal issue owing to rich possibilities in its applications.

Here we study the role of spin-resolved charge and heat transport in ultrafast demagnetization of thick magnetic metal using Thermodynamic μT-model [3] and obtain spatial and temporal evolution of magnetization. We also present the role of applied fluence and transport channels.

[1] E. Beaurepaire, J.-C. Merle, A. Daunois and J.-Y. Bigot, Phys. Lett. 76, 4250 (1996).

[2] Y. Liu et al. JMMM 502, 166477 (2020).

[3] B. Y. Mueller and B. Rethfeld, Phys. Rev. B 90, 144420 (2014).

O 37.4 Tue 10:30 P

The role of magnon-phonon hybridization in the lifetime broadening of surface states in rare-earth metals — •Bo Liu, Huijuan Xiao, and Martin Weinelt — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

Magnons and phonons are fundamental quasiparticle excitations in magnetic materials. Here we show that magnon-phonon hybridization plays an important role in the lifetime broadening of the surface state of ferromagnetic terbium due to large spin-lattice coupling in this material. This is evidenced by a comparison with Gd that has almost the same electronic structure as Tb but negligible 4f spin-orbit coupling. For the Gd surface state we show that magnon emission determines the photo-hole relaxation at low temperatures where the minority spin component exhibits clearly larger linewidth broadening than the majority component. With increasing temperature electron-phonon scattering becomes dominant evidenced by a larger coupling parameter λ in the majority spin channel. In contrast in Tb, majority and minority spin components of the surface state show very similar linewidths and the fitted electron-phonon coupling is twice as large as in Gd. The negligible spin dependence suggests the formation of magnon-polarons in line with our findings of ultrafast magnon emission in Tb [1].

[1] B. Frietsch et al., Science Advances 6, eabb1601 (2020).

O 37.5 Tue 10:30 P

Néel vector induced manipulation of valence states in the collinear antiferromagnet Mn2Au — •Hans-Joachim Elmers[1], S. V. Chernov[1], S. P. Bommanaboyena[1], S. Yu. Bodnar[1], K. Medjanik[1], S. Babenkov[1], O. Fedchenko[1], D. Vasilyev[1], S. Y. Agustsson[1], C. Schlueter[2], A. Gloskovskii[2], Y. Matveyev[2], V. N. Strocov[5], Y. Skourski[3], S. Dsouza[4], J. Minar[4], L. Šmejkal[1], J. Sinova[1], M. Klaeui[1], G. Schoenhense[1], and M. Jourdan[1] — [1]Institut für Physik, Universität Mainz, Germany — [2]DESY, Hamburg, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [4]University of West Bohemia, Czech Republic — [5]Paul Scherrer Institut, Switzerland

Manipulation of the electronic valence states of the collinear metallic antiferromagnet Mn_2Au was achieved by reorienting the direction of the staggered magnetisation (Néel vector). Pulsed magnetic fields of 50 T were used to direct the sublattice magnetisations of capped epitaxial Mn_2Au (001) thin films perpendicular to the applied field direction by a spin-flop transition. The electronic structure was investigated by hard X-ray angular-resolved photoemission spectroscopy. Our results confirm that the magnetic order parameter in real space provokes considerable changes of electronic states in reciprocal space near the Fermi Level and close to the X points. [1] ACS Nano 14, 17554 (2020).

O 37.6 Tue 10:30 P

Internal magnetic field increase at surface and interface of palladium thin films — •Gesa Welker[1], Martin de Wit[1], Tjerk H. Oosterkamp[1], John A. Mydosh[1], Thomas Prokscha[2], and Lucia Bossoni[1,3] — [1]Leiden Institute of Physics, Leiden University, The Netherlands — [2]Laboratory for Muon Spin Spectroscopy, Paul Scherrer Institute, Villingen, Switzerland — [3]C.J. Gorter Center for High Field MRI, Department of Radiology, Leiden University Medical Center, The Netherlands

We experimentally investigated three undoped and iron-doped palladium (Pd) 100 nm thin films and found an increased internal magnetic field at the surface and interface compared to the bulk-like middle of the film. Pd surfaces have recently become of interest in the field of spin-orbitronics. Furthermore Pd nanomaterial shows many applications where surface properties play a role, such as for example catalysis, magnetoresistance spin valves and phase coherence superconducting junctions. Understanding the magnetic surface properties of Pd is therefore relevant for various fields of research.

In our low-energy muon spin spectroscopy (MuSR) study, we implanted muons in Pd samples at varying depths to probe the local magnetic field in the implantation region. The field increase at the

surface/interface is temperature-independent, stronger for iron-doped samples, accompanied by an increased field inhomogeneity and extending over a few nanometers. We discuss potential origins for this magnetic surface state. Orbital moments induced by the surface/interface and localized spins/charges are the most likely explanation.

O 37.7 Tue 10:30 P

Local pairwise exchange interactions for noncollinear states in itinerant-electron magnets — •Ksenija Vodenkova[1] and Pavel Bessarab[1,2] — [1]ITMO University, St. Petersburg, Russia — [2]University of Icelad, Reykjavik, Iceland

The microscopic origin of the exchange interactions for noncollinear ordering of atomic magnetic moments in itinerant-electron systems is a subject of ongoing scientific discussions. In this work, we derive by means of the multiple-scattering theory a general expression for pairwise magnetic exchange interaction parameters for an arbitrary noncollinear, nonstationary magnetic state. In contrast to previous approaches, our formalism takes into account the variation of the fast degrees of freedom such as charge density and magnetic moment length. Application of the formalism to a tight-binding model reveals a range of magnetic systems that can be described by a classical Heisenberg Hamiltonian reasonably well. For other systems, our approach makes it possible to systematically derive atomistic spin Hamiltonians beyond the Heisenberg model. Moreover, the expression for the pairwise interaction tensor describes a local curvature of the energy surface of the system as a function of the orientation of magnetic vectors. This can be used in various contexts including description of thermal stability of magnetic states within the harmonic transition state theory and efficient identification of stable magnetic configurations using the Newton-Raphson method.

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