MA 56: Spin-Hall effects

Time: Friday 9:30–11:15 Location: H 0112

MA 56.1 Fri 9:30 H 0112

Spin transport due to interfacial spin-orbit coupling — •Juan Borge — University of the Basque Country

The inversion symmetry breaking at the interface between different materials generates strong spin-orbit coupling (SOC). This SOC is responsible of different spin phenomena. It generates spin loss at the interface, spin-to-charge, spin-to-spin and charge-to-charge conversion. We will study these phenomena in different metal/metal and ferromagnet/insulator bilayers generated by this interfacial SOC.

MA 56.2 Fri 9:45 H 0112

Spin-pumping in $La_{0.7}Sr_{0.3}MnO_3$/$LaNiO_3$/Pt heterostructures — •Christoph Hauser[1], Camillo Ballani[1], Christian Eisenschmidt[1], Frank Heyroth[2], and Georg Schmidt[1,2] — [1]Martin-Luther Universität Halle-Witteberg, Institut für Physik, Halle — [2]Interdisziplinäres Zentrum für Materialwissenschaften, Universität Halle, Halle

We have investigated spin pumping and the inverse spin Hall effect in heterostructures based on Lathanum Strontium Manganite (LSMO) and Lanthanum Nickel Oxide (LNO). The layers are deposited by pulsed laser deposition on different substrates. Magnetic and structural characterization is done by X-ray, TEM, SQUID magnetometry and ferromagnetic resonance at 120 K. Spin pumping and inverse spin Hall effect are also measured at T = 120 K below the Curie temperature of the LSMO. For LSMO/LNO additional damping in FMR could be detected, however the ISHE signal is too small to be distinguished from artefacts related to rectification of the RF signal in the LSMO. For LSMO/LNO/Pt trilayers, however, a clear ISHE can be detected, indicating that the spin scattering in the LNO is relatively weak while spin puming from the LSMO through the LNO is quite efficient.

MA 56.3 Fri 10:00 H 0112

Spin-charge conversion in PBTTT π-conjugated polymer — •Mohammad M. Qaid[1], Olga Zadvorna[2], Henning Sirringhaus[2], and Georg Schmidt[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, 06120 Halle — [2]Cavendish Laboratory, University of Cambridge, J. J. Thomson Avenue, Cambridge CB3 0HE, United Kingdom

Spin pumping can be used to inject a pure spin current from a ferromagnet into a conducting non-magnet. By the inverse spin-Hall effect (ISHE) this spin current can be converted into a charge current, an effect also dubbed spin-charge conversion. We have investigated the ISHE in the π-conjugated polymer poly (2,5-bis (3-hexadecylthiophen-2-yl) thieno [3,2-b] thiophene) PBTTT doped with F4TCNQ. The material is deposited on a ferrimagnetic yttrium iron garnet (YIG) thin film. In ferromagnetic resonance a spin current is injected from the YIG into the PBTTT and the inverse spin-Hall effect can be measured in the organic semiconductor. We have investigated the ISHE for different PBTTT thicknesses and also for samples which were annealed in order to change the doping. In addition we have excluded the Nernst effect which can be induced by thermal gradients caused by the RF excitation.

MA 56.4 Fri 10:15 H 0112

Surface magnetization probed by spin Hall magnetoresistance — •Saül Vélez[1,2], Juan Manuel Gomez-Perez[1], Miren Isasa[1], Edurne Sagasta[1], Amilcar Bedoya-Pinto[1], Lauren McKenzie-Sell[3], Mario Amado[3], Jason W. A. Robinson[3], Josep Fontcuberta[4], Vitaly Golovach[5,6], F. Sebastian Bergeret[5], Luis E. Hueso[1,6], and Felix Casanova[1,6] — [1]CIC NanoGUNE — [2]ETH Zürich — [3]University of Cambridge — [4]ICMAB-CSIC, UAB — [5]CFM-MPC (CSIC-UPV/EHU) and DIPC — [6]IKERBASQUE

Spin Hall magnetoresistance (SMR) in heavy metal(HM)/ferromagnetic insulator(FMI) bilayers is a novel effect governed by the spin transport across the HM/FMI interface. I will show the importance of the interface details in SMR in three different FMI systems: spinel CoFe2O4 (with antiphase boundaries) [1], perovskite LaCoO3 (a ferromagnet induced by epitaxial strain) [2] and garnet Y3Fe5O12 (with surface magnetic frustration due to ion-milling [3] or to ultrathin growth [4]). The SMR measurements allow us to extract the complex surface magnetic properties of those films, which are radically different to their bulk counterparts. Our results point SMR as a new powerful tool for probing the magnetic properties of surfaces.

[1] M. Isasa et al., Phys. Rev. Appl. 6, 034007 (2016). [2] S. Vélez et al., submitted. [3] S. Vélez et al., Phys. Rev. B 94, 174405 (2016). [4] J. M. Gómez-Pérez et al., submitted.

*Currently working at ETH Zürich with Prof. Fiebig and Prof. Gambardella.

MA 56.5 Fri 10:30 H 0112

Spin Hall magnetoresistance in antiferromagnetic NiO — Johanna Fischer[1], Olena Gomomay[2], Richard Schlitz[3], Kathrin Ganzhorn[1], Nynke Vlietstra[1], Matthias Althammer[1], Hans Huebl[1], •Matthias Opel[1], Rudolf Gross[1], Sebastian T.B. Goennenwein[3], and Stephan Geprägs[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Institut für Physik, Johannes Gutenberg Universität Mainz, Germany — [3]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, Germany

We investigate the spin Hall magnetoresistance (SMR) effect in thin film bilayer heterostructures of the paramagnetic metal Pt and the antiferromagnetic insulator NiO. While rotating an external magnetic field in the easy plane of NiO, we record the longitudinal and the transverse resistivity of the Pt layer and observe an amplitude modulation consistent with the spin Hall magnetoresistance. In comparison to Pt on collinear ferrimagnets [1], this modulation is phase shifted by 90° and its amplitude strongly increases with the magnitude of the magnetic field [2]. We explain the observed magnetic field-dependence of the spin Hall magnetoresistance in a comprehensive model taking into account magnetic field induced modifications of the domain structure in antiferromagnets [2]. With this generic model we are further able to estimate the strength of the magnetoelastic coupling [2]. — This work is supported by the DFG via SPP 1538.

[1] M. Althammer *et al.*, Phys. Rev. B **87**, 224401 (2013).
[2] J. Fischer *et al.*, submitted to Phys. Rev. B, arXiv:1709.04158.

MA 56.6 Fri 10:45 H 0112

Unidirectional spin Hall magnetoresistance in highly spin polarized Heusler compound Co_2MnSi — •Christian Lidig, Laura Weisshoff, Stanislav Bodnar, Mathias Kläui, and Martin Jourdan — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

The unidirectional spin Hall magnetoresistance (USMR) effect was recently experimentally observed [1] and theoretical described [2] in heavy metal/ ferromagnetic metal bilayer systems. This effect can be used to probe the magnetic state at the interface between the ferromagnet and heavy metal and it scales, similar to the giant magnetoresistance effect, with the spin polarization of the ferromagnet [2]. Correspondingly highly spin polarized materials, for example half metallic materials, should yield to larger effects. Previous photoemission experiments proved the half metallicity of Co_2MnSi (CMS) and showed a high spin polarization (93%) for a free surface of CMS [3]. However, it is not clear how the high surface spin polarization effects the spin transport measurements. Here I will present spin hall magnetoresistance measurements on CMS / Pt bilayer structures showing a large unidirectional spin hall magnetoresistance effect, originating from the high spin polarization of CMS. [1] C.O. Avci et al., Nat Phys. **11**, 570 (2015). [2] S.S.-L. Zhang et al., Phys Rev B, **94**,140411 (R) (2016). [3] M. Jourdan et al., Nat. Commun. **5**, 3974 (2014).

MA 56.7 Fri 11:00 H 0112

Thicknesses effect of MnGa and Pt on current-induced switching spin orbit torque (SOT) in CoGa/$L1_0$ MnGa/(CoGa)/Pt structure with perpendicular magnetic anisotropy (PMA) — •Reza Ranjbar[1,2], Kazuya Suzuki[1], and Shigemi Mizukami[1] — [1]WPI-Advanced Institute for Materials Research, Tohoku University, Sendai, Japan — [2]Current affiliation: Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

The use of SOT has attracted much attention as one of the ways to electrically manipulate the magnetization of magnetic thin films by applying an electrical current [1]. Tetragonal Heusler-like MnGa alloy have very low net-magnetic moments, high PMA, low Gilbert damping, and high spin polarization. Recently, we discovered low-temperature method of chemically growing 1–3-nm-thick MnGa films on B2 ordered CoGa [2]. This enabled us to investigate the SOT in MnGa alloy and then we reported current-induced SOT magnetization switching in CoGa/MnGa/Pt and CoGa/MnGa/MgO films [3,4]. Here, we present the results of our study on current-induced SOT switching in perpendicularly magnetized CoGa/MnGa/Pt trilayers with different thicknesses of MnGa and Pt. We found that the SOT switching is primarily due to the spin-Hall effect. The effect of MnGa (Pt) thickness is discussed in terms of the magnetic properties (resistivity).

[1] I. M. Miron *et al.*, Nature **476** (2011) 189. [2] K. Z. Suzuki *et al.*, Jpn. J. Appl. Phys. **55** (2016) 010305(R). [3] R. Ranjbar *et al.*, Jpn. J. Appl. Phys. **55** (2016) 120302(R). [4] M. Takikawa *et al.*, Appl. Phys. Express **10** (2017) 073004.