MA 27: Spin Electronics / Spininjection in Heterostructures

Time: Wednesday 16:45–17:45 Location: HSZ 103

MA 27.1 Wed 16:45 HSZ 103

The interface of tunnelling junctions with the Heusler electrode $Co_2Cr_{0.6}Fe_{0.4}Al$ — •Martin Jourdan, Christian Herbort, Elena Arbelo Jorge, Michael Kallmayer, and Hans Joachim Elmers — Institut für Physik, Johannes Gutenberg Universität, Staudingerweg 7, 55128 Mainz, Germany

The compound $Co_2Cr_{0.6}Fe_{0.4}Al$ was the first Heusler material for which half metallic properties and a magnetic ordering temperature well above room temperature were predicted. However, no Jullière spin polarisation larger than $\simeq 60\%$ could be observed up to now. The affinity of Cr for oxidation is considered to be the origin for this reduced value. We improved the vacuum condition of our preparation system to below 10^{-9}mbar. This resulted in a pronounced change of the morphology of the rf sputter deposited Al layer which is deposited on top of the Heusler electrode in order to become the tunnelling barrier after oxidation. In situ STM investigation show the growth of Al islands on the $Co_2Cr_{0.6}Fe_{0.4}Al$ surface. This growth mode results in an increased roughness of the barrier, which limits the achievable tunnelling magnetoresistance (TMR). Alternative methods of barrier deposition are employed and investigated by in situ STM and RHEED. Additionally, the effect of the Al deposition method and oxidation process on the surface magnetisation of the Heusler electrode is investigated by XMCD-TEY experiments.

MA 27.2 Wed 17:00 HSZ 103

Optimized spin-injection and detection in lateral all-metal spin-valve devices with integrated tunnel barriers — •Andreas Vogel, Jeannette Wulfhorst, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Injection, manipulation, and detection of spin-polarized currents are fundamental issues in spintronics. We study the spin-dependent transport in lateral all-metal spin-valve devices with different tunnel barriers at the interface between the ferromagnetic electrodes ($Ni_{80}Fe_{20}$) and the interconnecting metal strip (Al or Cu). A tunnel barrier can enlarge the spin polarization of the injected current [1-3]. Different total conductivities per cross-sectional area Σ_C of the aluminum oxide tunnel barriers are achieved by varying the oxygen pressure, the oxidation time, and the thickness of the naturally oxidized Al film. The spin-dependent transport in nonlocal geometry is described theoretically [3]. Transport measurements at temperatures of liquid helium are performed and compared to the theoretical description. A nonlinear increase of the spin polarization in the normal metal is observed for a decreasing tunnel conductance Σ_C. We experimentally verify a saturating behavior for lower Σ_C.

[1] F. J. Jedema et al., Nature **416**, 713 (2002)
[2] S. O. Valenzuela et al., Appl. Phys. Lett. **85**, 5914 (2004)
[3] A. van Staa, J. Wulfhorst, A. Vogel, U. Merkt, and G. Meier, Phys. Rev. B **77**, 214416 (2008)

MA 27.3 Wed 17:15 HSZ 103

Determination of spin injection and transport in a ferromagnet/organic semiconductor heterojunction by two-photon photoemission — •Mirko Cinchetti[1], Kathrin Heimer[1], Jan-Peter Wüstenberg[1], Oleksiy Andreyev[2], Michael Bauer[2], Stefan Lach[1], Christiane Ziegler[1], Yongli Gao[3], and Martin Aeschlimann[1] — [1]University of Kaiserslautern, Germany — [2]Universität Kiel, Germany — [3]University of Rochester, USA

A fundamental prerequisite for the implementation of organic semiconductors (OSC) in spintronics devices is the still missing basic knowledge about spin injection and transport in OSC. Here, we consider a model system consisting of a high-quality interface between the ferromagnet cobalt and the OSC copper phthalocyanine (CuPc) [1]. We focus on interfacial effects on spin-injection and on the spin transport properties of CuPc. Using spin-resolved two-photon photoemission we have measured directly and in-situ the efficiency of spin injection at the cobalt/CuPc interface. We report a spin injection efficiency of 85%-90% for injection into unoccupied molecular orbitals of CuPc. Moreover, we estimate an electron inelastic mean free path in CuPc in the range of 1nm and a much higher quasi-elastic spin-flip length. We demonstrate that quasi-elastic spin-flip processes with energy loss smaller than 200 meV are the dominant microscopic mechanism limiting the spin diffusion length in CuPc.

[1] M. Cinchetti et al., Nature Materials, DOI:10.1038/NMAT2334

MA 27.4 Wed 17:30 HSZ 103

Study of the Spin Properties of the Organic Semiconductor CuPc doped by Alkali Metals — •Sabine Neuschwander, Jan-Peter Wüstenberg, Alexander Fischer, Mirko Cinchetti, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, 67663 Kaiserslautern, Germany

It has been recently shown [1], that the spin-resolved two-photon photoemission (SR-2PPE) is a method allowing to collect direct experimental information about the spin properties of interfaces with OSC, such as the spin injection efficiency and the spin transport properties of OSC. Such knowledge is a fundamental prerequisite for the implementation of OSC-based spintronics devices [2]. Following the approach presented in [1], we considered the model system of a namely the heterojunction between a cobalt thin film and the OSC copper phthalocyanine (CuPc). According to [3] the electronic structure of CuPc can be modified by alkali metal doping. In particular, it is known that Cs and Na doping results in the lowering of the the energy of the unoccupied molecular orbital (LUMO) and highest occupied molecular orbital (HOMO) of CuPc. This reduction can be specifically tuned in order, to study the spin injection in the LUMO+1 state with SR-2PPE. Our results show that, resonant excitation from an occupied 3d-bulk band into the LUMO+1 gives rise to an almost 100% spin injection efficiency and to an extremely high quasi elastic spin flip length in CuPc.

[1] M. Cinchetti et al., DOI:10.1038/NMAT2334 (2008) [2] Sanvito, S., NMAT 6, 803-804 (2007) [3] H. Ding et al., APL 92,053309 (2008)