DS 39: Magnetism in Thin Films: Interaction Phenomena and Heterostructures

Time: Friday 10:15–12:00 Location: H 2032

Invited Talk DS 39.1 Fri 10:15 H 2032

Vortex Manipulation in Superconductor/Ferromagnet Hybrid Nanosystems(*) — •Victor Moshchalkov — INPAC-K.U.Leuven, Belgium

Artificial hybrid superconductor-ferromagnet (S/F) systems have been used to reveal the interplay between competing superconducting and magnetic order parameters, and to verify the existence of new physical phenomena, including the domain-wall superconductivity (DWS) and the reversed domain superconductivity (RDS)(Nature Materials 3, 793 (2004), Phys. Rev. Lett. 95, 227003 (2005), Phys. Rev. Lett. 95, 237003 (2005), Appl. Phys. Lett. 90, 182501 (2007)). Low-temperature scanning laser microscopy (LTSLM) together with transport measurements were carried out on $Nb/PbFe_{12}O_{19}$ hybrids in order to reveal local variations of superconductivity induced by the magnetic field template produced by the ferromagnetic substrate. Comparative analysis of the LTSLM and the MFM images has convincingly demonstrated the presence of the RDS (Phys. Rev. Lett. 96, 247003 (2006)). Periodic arrays of magnetic dots were used to investigate tunable field-induced superconductivity caused by the local field compensation with the stray fields of the magnetic dots with a variable magnetization. Critical currents and nucleation of superconductivity were controlled by using different cycles to magnetize the dots (Phys. Rev. B, 74, 220509 (2006)).

(*) In collaboration with W. Gillijns, J. Fritzsche, N. Schildermans, Q.H. Chen, K. De Keyser, A. Silhanek, J. Van de Vondel, A. Aladyshkin, K. Vervaeke, C.C. de Souza Silva, C. Carballeira, Z.R. Yang, V. Metlushko, D. Koelle, H.Eitel,R.Kleiner, R.Szymczak

Invited Talk DS 39.2 Fri 10:45 H 2032

Investigating the interaction between single-crystalline antiferromagnetic films and ferromagnets — •Wolfgang Kuch — Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin

The lack of detailed understanding of the coupling between an antiferromagnetic (AF) and a ferromagnetic film (FM) is in part due to the incomplete characterization of the interface in the sputtered polycrystalline samples that are typically used. Investigations of the AF/FM interface coupling at well-characterized single-crystalline interfaces can help to tackle this issue. I will present combined magneto-optical Kerr effect (MOKE) and layer-resolved magnetic imaging studies using x-ray magnetic circular dichroism (XMCD) and a photoelectron emission microscope (PEEM) for the investigation of single-crystalline systems. I will focus on Fe in contact to the oxidic antiferromagnet CoO, grown epitaxially on Ag(001), and on metallic systems containing FeMn as antiferromagnet, deposited on Cu(001). The pronounced layer-by-layer growth of the latter provides the opportunity to controllably tune the interface roughness on the atomic scale. Interestingly, the antiferromagnetic ordering temperature of the FeMn layer depends strongly on the magnetization direction of the adjacent FM layer, providing clear evidence for a magnetic proximity effect in which the FM layer substantially influences the ordering temperature of the AF layer.

Results were obtained in collaboration with F. Offi, L. I. Chelaru, M. Kotsugi, J. Wang, J. Kirschner, R. M. Abrudan, J. Miguel, K. Lenz, and S. Zander.

DS 39.3 Fri 11:15 H 2032

FeZr-based multilayers – a frustrated XY system? — •Andreas Liebig[1], Panagiotis Korelis[1], Gabriella Andersson[1], Björgvin Hjörvarsson[1], Hans Lidbaum[2], and Klaus Leifer[2] — [1]Dep. of Physics, Uppsala University, Uppsala, Sweden — [2]Dep. of Engineering Sciences, Uppsala University, Uppsala, Sweden

Anisotropy and frustration terms can lead to a reentrant spin-glass state at low temperatures in the amorphous ferromagnet $Fe_{90}Zr_{10}$.

Here, we present a study of $Fe_{90}Zr_{10}/Al_{70}Zr_{30}$ amorphous multilayers, using MOKE and a SQUID magnetometry. The structural quality was verified using X-ray reflectivity as well as HR-TEM and the chemical composition was determined by RBS.

Interlayer exchange coupling across the amorphous $Al_{70}Zr_{30}$ layer is weak and the ordering temperature is therefore almost exclusively dominated by the thickness of the $Fe_{90}Zr_{10}$ layers. Multilayers with $Fe_{90}Zr_{10}$ layers in the nm range are found to have extraordinarily low remnant and coercive fields – in fact, so low that the definition of a magnetic transition temperature becomes difficult. The magnetization of the layers collapses, with exceedingly high susceptibility above the apparent ordering temperature.

A conceptual model of the transition will be given, involving the competition between the local anisotropy and the exchange coupling. The results can have far reaching consequences for the understanding of the interplay between finiteness and ordering. For example, the use of nearest neighbour interaction is found to be insufficient for describing the observations.

DS 39.4 Fri 11:30 H 2032

Highly ordered spin-state in an epitaxial spin-valve — •Frank Brüssing, Boris Toperverg, Hartmut Zabel, and Katharina Theis-Bröhl — Department of Physics 4, Ruhr-University Bochum, D-44780 Bochum, Germany

Several periods of Fe and Co films separated by Cr layers were grown on MgO (001) by molecular beam epitaxy to form an epitaxial spin valve superlattice. We adjusted the film thicknesses of Fe and Co to have similar magnetic moments in the both magnetic layers. In order to get a proper spin-valve behavior we have chosen a Cr spacer thickness which provides a week antiferromagnetic coupling. The quality of the layering and the epitaxial relationship were verified via x-ray methods. For investigating of the arrangement of the magnetic moments in the different magnetic layers we performed polarized neutron reflectometry studies in the as-grown state and with an applied magnetic field. Ferromagnetic and antiferromagnetic alignment between neighboring Co and Fe layers can be recognized via intensity variations on the nuclear [Co/Cr/Fe/Cr] superlattice peaks which are different for odd and even orders. Interestingly, additional half-order peaks appear in the asgrown state indicating a new magnetic state. In this state an antiferromagnetic alignment between complete neighboring [Co/Cr/Fe/Cr] unit cells occurs suggesting a highly-ordered demagnetized state induced by dipolar interaction during growth. Applying a magnetic field destroys this state which also can not be recoverd during field reversal. This project was supported by the DFG via SFB491.

DS 39.5 Fri 11:45 H 2032

Structural characterization and magnetization profile of CoFeB/MgO multilayers for Magnetic Tunnel Junctions — •Miriana Vadalà[1], Kirill Zhernenkov[1], Max Wolff[1], Oleg Petracic[1], Kurt Westerholt[1], Boris P. Toperverg[1], Hartmut Zabel[1], Piotr Wisniowski[2], and Susana Cardoso[2] — [1]Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, Germany — [2]INESC, Lisbon, Portugal

We present structural and magnetic results from the characterization of CoFeB/MgO multilayers sputtered at different deposition pressures on Si/SiO_2 substrates. From X-ray scans we obtain the layer thicknesses and the interface roughnesses. Magnetic measurements show different results depending on the growth conditions. For all samples the magnetic anisotropy is negligible as intended by the growth of amorphous CoFeB layers. For smooth layers (lower Ar pressure) one finds a step-like hysteresis curve, whereas the curves are strongly rounded for the rougher system (higher Ar pressure). This could hint to a more decoupled vs. a stronger coupled remagnetization behavior, respectively. To shed more light on the behaviour of the alloy at the interface to the MgO layer, we have taken polarized neutron reflectivity data [1]. Similar to the $FeCo/Al_2O_3$ system [2] we observe for the multilayer with rough interfaces a loss of a ferromagnetic correlation at remanence, indicating that each CoFeB layer forms an uncorrelated domain structure. Financial support EU-RTN ULTRASMOOTH, SFB 491 and BMBF 03ZA6BC1 are acknowledged.

[1] M. Wolff, et al. Thin Solid Films 515, 5712 (2007)
[2] S. Bedanta, et al , PRB 74, 054426 (2006).