TT 9: Superconductivity - Heterostructures, Andreev Scattering, Proximity Effect, Coexistence

Time: Monday 16:15–18:00 Location: H20

TT 9.1 Mon 16:15 H20

Nb Layers with Advanced Superconducting Properties as a Base for Proximity Effect Investigation. — •Anatolie Sidorenko[1,2], Vladimir Zdravkov[1], Andrei Prepelitsa[1], and Andrei Sudru[1] — [1]Institute of Electronic Engineering and Industrial Technologies ASM, MD-2028 Kishinev, Moldova — [2]3Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

High quality, large area Nb films (size 500 mm x mm) and constant thickness were deposited by DC magnetron sputtering in a commercial *Leybold Z400* vacuum system. Homogeneity and proper thickness of the Nb layer provided by the target-holder movement during the DC sputtering was achieved by using a specially constructed arrangement including a PC-controllable motor with gear. Rutherford backscattering spectrometry was used for precise thickness measurements. An increase of the superconducting parameters, i.e. the critical temperature rose more than 1.5 K and the superconducting coherence length was 30-35 % larger in comparison with the parameters for films with comparable thickness, which were prepared with common technique, was observed. The developed preparation technique for Nb films was used as a base for proximity effect investigation in layered S/F structures.

TT 9.2 Mon 16:30 H20

Spin-active scattering matrices for interfaces between superconductors and half metals — •Gero Bergner, Andreas Poenicke, Matthias Eschrig, and Gerd Schön — Institut für Theoretische Festkörperphysik und DFG-Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe

Recently a non-vanishing supercurrent has been observed in a Josephson junction that contains an extended region of half-metallic CrO_2 between two singlet superconducting electrodes [1]. A theory to explain this phenomenon has been established in Refs. [2,3] that is formulated in terms of spin-active interface scattering matrices. Spin mixing and breaking of spin-rotation symmetry around the magnetization axis of the half metal are necessary ingredients for creation of equal spin triplet pairing amplitudes that can penetrate the half metal over a long range. Here, we present a microscopic model for a scattering matrix that exhibits such characteristics. We show that disorder of local magnetic moments at the interface between a superconductor and a ferromagnet with biaxial anisotropy in the interface region leads to the observed current conversion between singlet and equal spin triplet supercurrents. We discuss our results by comparing with the experimental findings of biaxial anisotropy and triplet supercurrents in the half metal CrO_2 [1].

[1] R.S. Keizer *et al.*,Nature **439**, 825-827(2006).
[2] M. Eschrig *et al.*,Phys. Rev. Lett. **90**, 137003 (2003).
[3] M. Eschrig *et al.*,cond-mat/0610212 (2006)

TT 9.3 Mon 16:45 H20

Superconducting spin valve structures grown on [Fe/V]-(001) superlattices — •Gregor Nowak[1], Kurt Westerholt[1], Moreno Marcellini[2], Andreas Liebig[2], Hartmut Zabel[1], and Björgvin Hjörvarsson[2] — [1]Experimentalphysik /Festkörperphysik, Ruhr - Universität Bochum — [2]Department of Physics, University of Uppsala, Sweden

In a superconducting F1/S/F2 epitaxial grown spin valve trilayer structure the superconducting V layer (S) is imbed in to two ferromagnetic Fe layers F1 and F2. Model calculations [1] based on the F/S proximity effect have shown that with suitable parameters for the thicknesses and correlations lengths of the F and S-layers the superconductivity can be switched off and on by rotating the magnetization of F1 and F2 from a parallel to an antiparallel orientation. Experimentally, however, it turned out to be quite difficult to optimize the F1/S/F2 device and until now only very small differences of the superconducting (SC) transition temperature (Tc) between the parallel and antiparallel orientation has been observed [2]. The epitaxial quality of the superconducting V-layer S reduces the impurity and surface scattering of the electrons to an extend that the SC correlation length becomes comparable to the V-film thickness, which is prerequisite for observing a definite SC spin valve effect. We clearly observe the SC spin valve effect with a difference in Tc for the ferromagnetic layers in the parallel or antiparallel orientation of up to 30 mK. References: [1] L. R. Tagirov, Phys. Rev. Lett. , 83, 2058, (1999) [2] J.Y. Gu, C.-Y. You, J. S. Jiang, and S. D. Bader, Phys. Rev. Lett. , 89, 267001, (2002)

Invited Talk TT 9.4 Mon 17:00 H20

Crossed Andreev Reflection in Superconductor-Ferromagnet Hybrid Structures — •Detlef Beckmann[1], Jakob Brauer[1], Dagmar Rall[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik — [3]Physikalisches Institut, Universität Karlsruhe

We report on conductance measurements on multiterminal superconductor nanostructures, where two ferromagnetic or normal-metal leads form tunnel contacts to a single superconductor. The focus is on transport at energies below the superconducting gap, and length scales below the coherence length. We observe a negative non-local resistance which can be interpreted in terms of crossed Andreev reflection, a process where an electron incident from one of the leads gets reflected as a hole into the other, thereby creating a pair of spatially separated, entangled particles.

D. Beckmann, H.B. Weber and H.v. Löhneysen, Phys. Rev. Lett. **93**, 197003 (2004)
D. Beckmann and H.v. Löhneysen, cond-mat/0609766

TT 9.5 Mon 17:30 H20

Supercurrent through Semiconductor Quantum Wells in Parallel Magnetic Fields — •Franziksa Rohlfing[1], Thomas Geiger[1], Grigory Tkachov[2], Gustaaf Borghs[3], Christoph Strunk[1], and Dieter Weiss[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [3]IMEC, Leuven, Belgium

We investigate the transport properties through narrow InAs bridges in a 4-point configuration within the two-dimensional electron gas (2DEG), that is formed in the InAs inversion layer. Superconductivity is proximity induced into the 2DEG by two sputterdeposited niobium stripes across the bridge. In this way a ballistic Josephson junction is formed within the 2DEG. The critical current of these junctions is measured as a function of perpendicular and parallel magnetic field. In a magnetic field perpendicular to the 2DEG the well-defined Fraunhofer pattern is observed. On the other hand, when the 2DEG is oriented parallel to the magnetic field, a monotonic decay of the critical current is observed. The measurement data can be explained within the framework of two models that discuss the effect of the Doppler shift or the Zeeman splitting on the Andreev bound states, respectively.

TT 9.6 Mon 17:45 H20

Ferromagnetic-superconducting heterostructures: Direct evidence for spin polarized quasiparticle self injection — •Soltan Soltan[1,2], Joachim Albrecht[3], Maerit Djupmyr[3], and Hanns-Ulrich Habermeier[1] — [1]Max–Planck–Institut für Festkörperforschung, Heisenbergstr. 1, D–70569 Stuttgart, Germany — [2]Physics Department, Faculty of Science, Helwan University, 11792-Helwan, Cairo, Egypt — [3]Max–Planck–Institut für Metalforschung, Heisenbergstr. 1, D–70569 Stuttgart, Germany

Epitaxial heterostructures of half–metal colossal magnetoresistive LCMO (HM–CMR) and high-T_c superconducting YBCO(HTSC) are grown on $SrTiO_3$(100) single crystal substrates by pulsed laser deposition. New transport R(T), magnetization M(T), and Hall effect measurements has been done. The R(T) shows an upturn at T = 30K to normal state resistance below the superconducting transition temperature T_c = 50K. This upturn in the resistance is matching with magnetization saturation M_s(T) for the same heterostructure. We explain our new results as a direct evidence for spin–polarized quasiparticle self injection.