TT 7 Superconductivity & Solids At Low Temperature - Poster Session

Time: Monday 14:00–17:45 Room: P1

TT 7.1 Mon 14:00 P1

SupraTrans - a superconductively levitated transport system — •Christoph Beyer, Oliver de Haas, and Ludwig Schultz — IFW Dresden, PF 270116, D-01171 Dresden, Germany

Based on investigations on a toy sized model levitation train [1], a full working demonstrator for a superconductively levitated transport system has been developed. The levitation and guidance system is based on flux pinning in melt-textured bulk $YBa_2Cu_3O_{7-x}$ (YBCO) that stabilizes the vertical and lateral positions of the vehicle above the magnetic track. The track is made of Nd-Fe-B permanent magnets mounted within soft-magnetic iron yokes acting as flux collectors. The actual vehicle contains 4 cryostats. Using 10 rectangular shaped bulk YBCO blocks with dimensions of $35 \times 90 \times 15$ mm^3 in each of them a maximum total load of nearly 800 kg at 77 K has been achieved. More details about the capability of the system will be given in the contribution. The concept also includes a fast electromagnetic turnout switch to establish a highly branched transportation network. An experimental setup has been created for the toy sized model train and will complete the SupraTrans demonstrator.
[1] L. Schultz et al.; Z. Metallkd. 93, 1057

TT 7.2 Mon 14:00 P1

Rare Earth Nickel Borocarbide Thin Films and Related Compounds — •Tim Niemeier, Ruben Hühne, Günter Behr, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, 01171 Dresden

Epitaxial thin films of YNi_2B_2C and related rare earth borocarbide compounds have been found to be a suitable alternative to single crystal growth for the characterisation of usual superconducting properties such as T_c, H_{c2} and J_c . Comparable results concerning the anisotropy require a good texture quality. For YNi_2B_2C, a new buffer layer architecture was developed, which improves both epitaxial growth and texture quality. The films were grown by pulsed laser deposition from stoichiometric and multicomponent molten targets under ultra-high vacuum conditions. Bare as well as buffered ceramic single crystals were used as substrates. Additionally, thin films of modified phase compositions such as $Y(Pt_xNi_{1-x})_2B_2C$ were investigated and the influence of disorder on the superconducting properties was studied. The critical temperature, the critical current density and also the properties of the upper critical field were determined and compared to polycrystal data.

TT 7.3 Mon 14:00 P1

Superconducting and magnetic properties of $RENi_2B_2C$ (RE=Y, Tb, Ho, Tm) single crystals — •Dmitri Souptel[1], Gunter Behr[1], Wolfgang Loser[1], Gunter Fuchs[1], Tilmann Leisegang[2], and Dirk Meyer[2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, Helmholtzstr. 20, 01171 Dresden — [2]Technische Universität Dresden, Institut für Strukturphysik D-01062 Dresden

High-quality single crystals of $RENi_2B_2C$ (RE=Y, Tb, Ho, Tm) intermetallic compounds have been grown by a floating zone technique with optical heating [1, 2]. Crystals are crack free, without traces of 2nd phases and single crystalline in the volumes of 6 mm in diameter and 25-40 mm in length. The high crystal perfection was confirmed by x-ray, metallographic and neutron methods. Physical properties depend strongly on small composition variation and the temperature of heat treatment. For instance $HoNi_2B_2C$ show a variety of properties: plain superconductivity (T_c about 8 K), re-entrant superconductivity (T_c about 8 K and loss of superconductivity between 4 - 6 K due to incommensurate magnetic ordering) and normal conducting behaviour. Origins of different superconducting properties and their anisotropic behaviour are related to crystal composition, lattice parameters and changes of lattice site occupancies of the composing elements.

[1] D. Souptel et al., J. Cryst. Growth 276 (3-4) (2005) 652-662 [2] D. Souptel et al., J. Cryst. Growth 275 (1-2) (2005) e91-e95

TT 7.4 Mon 14:00 P1

Magnetic quantum oscillations in the normal and superconducting state of nonmagnetic borocarbides — •O. Ignatchik[1], B. Bergk[2], M. Jäckel[2], J. Wosnitza[1], D. Souptel[3], G. Behr[3], and P. C. Canfield[4] — [1]Dresden High Magnetic Field Laboratory, Forschungszentrum Rossendorf, 01314 Dresden — [2]Institut für Festkörperphysik, Technische Universität Dresden, D-01062 Dresden — [3]Leibniz-Institut für Festkörper- und Werkstofforschung, D-01069 Dresden — [4]Condensed Matter Physics, Ames Laboratory, Ames, Iowa 50011, USA

We report on de Haas-van Alphen (dHvA) investigations of the nonmagnetic borocarbides YNi_2B_2C and $LuNi_2B_2C$. The measurements were carried out on high-quality single crystals by the torque method in magnetic fields up to 30 T. In the normal state the Fermi-surface topology has been analysed. In comparison with band-structure calculations several deviations are determined. Below the upper critical field, B_{c2}, in the vortex state an additional damping of the dHvA amplitudes appears. This damping is caused by the evolution from of the superconducting gap parameter. Concerning these topics we observe strong differences between differently grown crystals. The crystals produced by a zone-melting method show an abrupt vanishing of the dHvA signal at the upper critical field B_{c2}. In contrast, the flux grown crystals display a broader phase transition combined with a continuous decrease of the dHvA amplitude.

TT 7.5 Mon 14:00 P1

First-Principles Electronic Structure Study of Layered TB_2C_2 Compounds (T = Y, La, Lu) — •Alim Ormeci and Helge Rosner — MPI for Chemical Physics of Solids, Dresden, Germany

Metal borocarbides TB_2C_2, where T = Y and rare earth (R) metals, are layered compounds with metal atom layers alternating with the (B_2C_2) layers. The RB_2C_2 compounds crystallize in the tetragonal LaB_2C_2-type structure with symmetry $P4/mbm$ (SG 127). CaB_2C_2 also has the same crystal structure and is isoelectronic to MgB_2. However, due to heteropolar B-C bonds it is an insulator. The compound YB_2C_2, on the other hand, is a metal and a superconductor. Although there are some ambiguities about its crystal structure [1], it can be regarded as an electron-doped version of CaB_2C_2. Consequently, both the crystal and electronic structure of YB_2C_2, as well as the electron-phonon interactions in the (B_2C_2) layers are of interest.

We use the FPLO method to investigate the above mentioned aspects in YB_2C_2. In particular, we find that YB_2C_2 has the LaB_2C_2-type structure in agreement with the FP-LAPW results [1]. Furthermore, we study the effects of (i) possible disorder in the B-C network, and (ii) different stacking orders on the electronic properties. LaB_2C_2 and LuB_2C_2 are included in the study for comparative reasons.
[1] S. Khmelevskyi, et al. Supercond. Sci. Technol. **18** 422 (2005)

TT 7.6 Mon 14:00 P1

$CaSi_2$, the "antibonding sister" of MgB_2 — •Claire Loison and Helge Rosner — Max-Planck-Institut für Chemische Physik fester Stoffe, Nöthnitzer Str. 40, 01187 Dresden, Germany

After the suprising superconductivity of MgB_2 at 40 K, the superconductivity of other solids with the layered AlB_2-type has been discovered recently: $CaSi_2$, CaAlSi, SrAlSi ($T_c \sim$ 14 K, 8 K and 4 K respectively). At the same time, similar layered compounds, like the intercalated graphites YbC_6 and CaC_6 are discovered to superconduct at temperatures substancially higher than previously known for other intercalated graphites (6.5 K and 11 K respectively). Here, we study the electronic structure and the electron-phonon coupling of the superconducting phase of $CaSi_2$ using density functional theory, and compare it to MgB_2. The crystal structure of superconducting $CaSi_2$ is also of the AlB_2-type, with a slight buckling in the silicon planes. Superconductivity mechanism is similar in MgB_2 and $CaSi_2$, except that in $CaSi_2$ the *antibonding* σ^*-bands of the silicon layers are main contributor to the electron-phonon coupling, whereas in $CaSi_2$, it is the *bonding* 2p-σ-bands of boron. We investigate the influence of the buckling, which can be controled experimentally by the pressure, on the electron-phonon coupling. Finally, we discuss the possibility to find other superconductors in the familly of metal disilicides ASi_2 with A = Ba Ca, Lu, Sc, Yb.

TT 7.7 Mon 14:00 P1

Influence of aluminium substitution on the heat transport in single crystalline MgB_2 — •A.V. Sologubenko[1,2], N.D. Zhigadlo[2], S. M. Kazakov[2], J. Karpinski[2], and H.R. Ott[2] — [1]II. Physikalisches Institut, University of Cologne, 50937 Cologne, Germany — [2]Laboratorium für Festkörperphysik, ETH Hönggerberg, CH-8093 Zürich, Switzerland

We report data on the thermal conductivity $\kappa(T,H)$ of single-crystalline superconducting $Mg_{1-y}Al_yB_2$ ($y = 0.02, 0.07$) in the normal and mixed states at temperatures between 0.5 and 50 K, and in external magnetic fields H up to 50 kOe. The results are analyzed in terms of a combined phononic ($\kappa_{\rm ph}$) and quasiparticle (κ_e) heat transport and compared with our earlier results on pure and carbon-doped MgB_2. The substitution of Al for Mg leads to a considerable reduction of the field-induced κ_e, while $\kappa_{\rm ph}$ seems to be much less sensitive to impurities. The analysis of the $\kappa_e(H)$ data leads to the conclusion that the introduction of aluminium results in comparable enhancement of the intraband scattering in both the σ- and the π-band. This is in contrast to the carbon substitution for boron, which enhances mostly the intraband scattering in the σ-band. The interband scattering is rather weak in both cases.

TT 7.8 Mon 14:00 P1

Microwave properties of MgB_2 thin films prepared in situ by thermal evaporation combined with sputtering — •Rudolf Schneider, Alexander G. Zaitsev, Roland Hott, Fritz Ratzel, and Jochen Geerk — Forschungszentrum Karlsruhe, Institut für Festkörperphysik, P.O.B. 3640, D-76021 Karlsruhe, Germany

Superconducting MgB_2 thin films were prepared *in situ* using a combination of rf magnetron sputtering of B and thermal evaporation of Mg. The films exhibited T_c of up to 36 K. Microwave measurements were performed on 14×14 mm^2 films using both Cu-shielded and Nb-shielded sapphire puck resonators at the frequency of 18.8 GHz. The hf surface resistance (R_s) and the change of the hf surface reactance (ΔX_s) were determined. The films exhibited low R_s matching the literature results for high-quality MgB_2 films. Below 3 K R_s reached 3-5 $\mu\Omega$ which was the resolution limit of our measurement. The temperature dependence of both R_s and ΔX_s were in good agreement with BCS theory. From the R_s(T) dependence we obtained an energy gap $\Delta(0)\approx$ 3 meV. The measured variation of the London penetration depth with temperature, $\Delta\lambda_L$(T), was also in good agreement with the BCS model. Using the BCS relation between the energy gap and the penetration depth we fitted our experimental $\Delta\lambda_L$(T) data and obtained $\lambda_L(0)$ values which ranged for different films from 85 to 100 nm.

TT 7.9 Mon 14:00 P1

Effect of impurity additions on the superconducting properties of in situ-processed MgB_2 — •Marko Herrmann[1], Margitta Schubert[1], Wolfgang Häßler[1], Bernhard Holzapfel[1], and Ludwig Schultz[1,2] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Dresden University of Technology, Department of Physics, Institute for Physics of Solids, D-01062 Dresden, Germany

The MgB_2 powder was prepared by mechanical alloying of Mg, amorphous Boron and the additive. For studying the influence of the additive on the superconducting properties its amount was varied up to 20 m-%. Single elements as carbon as well as compounds like SiC were used as dopants. The result of the milling process was a partially reacted nano-sized precursor powder with a high reactivity which was hot pressed to bulk samples. Starting from the undoped MgB_2 with a critical temperature of 36 K and best current densities of 10 kA/cm^2 at 7.5 K and 4 T, the changes of the superconducting properties with the kind and amount of additive are described in detail.

TT 7.10 Mon 14:00 P1

TEM cross-section analysis of $La_2Zr_2O_7$ buffer layers for YBCO-coated conductors prepared by chemical solution deposition — •Leopoldo Molina[1], Sebastian Engel[2], Kerstin Knoth[2], Bernhard Holzapfel[2], and Oliver Eibl[1] — [1]Institute of Applied Physics, University of Tuebingen, Auf der Morgenstelle 10, D-72076 Tuebingen, Germany — [2]IFW Dresden, Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

Chemical solution deposition is a promising method to fabricate low cost buffer layers for YBCO-coated conductors. In this study we present transmission electron microscopy (TEM) analysis of cross-sectional and plan-view prepared $La_2Zr_2O_7$ buffer layers on biaxially textured Ni-W substrates for YBCO-coated conductors prepared by chemical solution deposition methods. The $La_2Zr_2O_7$ buffer layers were deposited on 100 μm thick Ni-W substrate and were heat treated at 900°C and 1050°C. TEM cross-section samples were prepared by conventional mechanical polishing and ion milling techniques. By means of transmission electron microscopy the grain size, the buffer layer thickness, the void size and void density and the orientation of LZO with respect to the Ni substrate was determined. The Ni-W substrate interface with the $La_2Zr_2O_7$ buffer layer was also investigated. Using two-beam imaging conditions bright-field, dark-field and energy spectroscopic images (ESI) were acquired. Chemical composition determination of the films and substrate was done by energy dispersive X-ray microanalysis (EDX).

TT 7.11 Mon 14:00 P1

Optimisation of $La_2Zr_2O_7$ buffer layers and CeO_2 cap layers on Ni RABiTS for YBCO coated conductors using chemical solution deposition — •Sebastian Engel, Kerstin Knoth, Thomas Thersleff, Heike Schlörb, Ruben Hühne, Ludwig Schultz, and Bernahrd Holzapfel — IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

Chemical Solution Deposition (CSD) has been used to prepare biaxially textured cerium oxide cap layers and $La_2Zr_2O_7$ (LZO) buffer layers on Ni RABiTS. For the cerium oxide cap layer, a precursor solution consisting of dissolved Ce(III)-acetate in propionic acid, 2,5-pentandion, and 2-propanol was used. The LZO precursor solution was prepared by dissolving La-, and Zr-2,4-pentanedionates in propionic acid. Both, prepared buffer and cap layers were dip-coated and subsequently heat-treated at various temperatures between T = 900°C and 1100°C under different gas flow conditions. The surface texture quality was analysed with Reflection High Energy Electron Diffraction (RHEED) and Electron Back Scattering Diffraction (EBSD). EBSD maps show nearly 100 % biaxially textured surfaces for the optimised LZO buffer layers and cerium oxide cap layer. Further surface properties were investigated by atomic force microscopy and secondary electron microscopy. 300nm thick $YBa_2Cu_3O_{7-\delta}$ test structures were prepared on this buffer layer system CeO_2 (CSD)/LZO (CSD)/ Ni-5 % W tape by pulsed laser deposition and characterised by resistivity measurements at 77 K in magnetic fields up to 9 T.

TT 7.12 Mon 14:00 P1

All CSD $YBa_2Cu_3O_{7-\delta}$ coated conductor on cube textured Ni-W substrates — •Kerstin Knoth, Sebastian Engel, Ruben Hühne, Steffen Oswald, Brigitte Schlobach, Steffen Strehle, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Chemical Solution Deposition (CSD) was used as a low cost method to prepare an all CSD $YBa_2Cu_3O_{7-\delta}$ (YBCO) coated conductor having a YBCO/CeO_2/$La_2Zr_2O_7$ (LZO)/Ni-5at%W architecture. The LZO and CeO_2 precursor solutions were prepared using new solution routes, whereas the trifluoroacetate (TFA) process was used for the preparation of the YBCO layer. A highly textured LZO/CeO_2 architecture was obtained on Ni-W after annealing at $T_A = 900\,°C$ in a reducing atmosphere. The TFA-YBCO layer was deposited afterwards and annealed at $T_A = 780\,°C$. The characterization of the CSD YBCO coated conductor was done using X-Ray Diffraction (XRD), Reflection High Energy Electron Diffraction (RHEED), SEM, AFM, X-Ray Photoelectron Spectroscopy (XPS) and cross sectional analysis using the Focussed Ion Beam (FIB) technique. The TFA-YBCO(200 nm)/CeO_2(60 nm)/LZO(400 nm)/Ni-W coated conductor showed a T_c of 91.0 K with a ΔT_c of 1.2 K. The critical current density J_c was below 1.0 MA/cm^2 compared to a PLD-YBCO/PLD-CeO_2/LZO(400 nm)/Ni-W test sample (PLD - Pulsed Laser Deposition) with $J_c = 1.0$ MA/cm^2. Nevertheless, these results are very promising towards the realization of an all CSD YBCO coated conductor.

TT 7.13 Mon 14:00 P1

Effect of H_2S treatment on the orientation and texture sharpness of MgO buffer layers on highly cube textured Ni-4at.%W tapes as a template for YBCO coated conductors — •Rainer Nast[1], Bernhard Obst[1], Oliver Stadel[2], and Wilfried Goldacker[1] — [1]Forschungszentrum Karlsruhe, Institut für Technische Physik, Postfach 3640, D-76021 Karlsruhe — [2]TU Braunschweig, Institut für Oberflächentechnik (IOT), Bienroder Weg 53, D-38108 Braunschweig

To achieve high current carrying capabilities in YBCO coated conductors based on cube textured metal substrates, the texture and stability of the buffer/metal interface is a necessary requirement. In this work cube textured Ni-4at.%W substrate tapes were subjected to different H_2S treatments and the texture development of post-deposited MgO buffer layers was studied. The in-plane orientation and the texture sharpness of the MgO layers was found to depend strongly on the heat treatment time in Ar-10 ppm H_2S. Increasing the time from 5 to 60 min at 800°C changes the in-plane orientation from 45° over 0° to 45° at 15 min and the texture sharpens continuously to an FWHM (220) of $< 6°$.

TT 7.14 Mon 14:00 P1

Physical properties of chemically deposited $La_2Zr_2O_7$ and CeO_2 buffer layers on cube textured Ni-4 at.% W substrates — •Gunter Kotzyba, Bernhard Obst, Rainer Nast, and Wilfried Goldacker — Forschungszentrum Karlsruhe, Institut für Technische Physik, P.O. Box 3640, 76021 Karlsruhe

The chemical solution deposition route for YBCO-coated conductors is of interest as a promising way to develop a low cost conductor. Thin films of $La_2Zr_2O_7$ and CeO_2 were prepared on Ni-4 at.% W by dip coating. The layers serve as buffer for depositing superconducting YBCO on top of it. We systematically investigated the dependence of the thickness on the viscosity and the concentration of the La (III) and Ce (IV) precursor solutions by means of a cone plate rheometer and an ICP OES. The roughness was analysed with a profilometer, the thickness determination was done by X-ray microanalysis. EBSD mappings show very good cube in-plane and out-of-plane texture.

TT 7.15 Mon 14:00 P1

dc and rf transport in normal and superconducting HTS, MgB_2, and Nb networks — •Jürgen Halbritter — Forschungszentrum Karlsruhe, Postfach 36 40

Island/grain boundaries occur naturally in film growth or sintering. The hindrance of electric transport by boundary resistances $R_{bn}(Wcm^2)$ in distances $a_J(\leq 10mm)$ is easy to measure in normal conducting transport in such granular networks. The resistivity $r(T) = R_{bn}/a_J + p(\rho^i(T) + \rho^i(0))$ is fitted to observations with percolation factors $p > 1$ by current diverting $a_J\rho^i(300K)$ boundaries with $R_{bn} \geq a_J\rho^i(300K)$ where $\rho^i(T) + \rho^i(0)$ is due to the grain interior (IG) and R_{bn}/a_J and p describes the effects of boundaries (GB) and the network. In the superconducting transport GB may act as Josephson junctions (JJ) with $j_{cJ}(A/cm^2)$ as current density. For superconducting networks is a simple separation in IG and GB not possible. But low I_c values, $p > 1$ and large R_{bn} values are clear indications for growth boundary limitations. Analysis of $I_c(T, B, q, \omega)$ as junction of temperature, field B, angle q and frequency ω give crucial information about GB and flux low or pinning of Josephson (JF) or Abrikosov fluxons (AF) in the network. The combination of normal and superconducting analysis is of crucial importance for dc, ac and rf engineering applications and for the understanding of the related material science.

TT 7.16 Mon 14:00 P1

Electronic structure calculations for YBCO/metal interfaces — •Udo Schwingenschlögl and Cosima Schuster — Institut für Physik, Universität Augsburg, 86135 Augsburg

Transport properties of heterostructures consisting of a metal and a correlated superconductor are of great importance for electronic devices based on HTSC. Using electronic structure calulations within density functional theory and the local density approximation, we investigate YBCO/metal interfaces. As the lattice mismatch between YBCO and Pd is rather small (0.7%), we choose Pd as the metallic constituent. It is generally accepted that the carrier density is modified at grain boundaries. Since this band bending should take place on the length scale of the lattice constant it can be reproduced by LDA supercell calculations. In particular, we use a supercell consisting of two YBCO unit cells alternating with five Pd layers along the orthorhombic c-axis. Following experimental results, the YBCO layers entering our calculations terminate by CuO chains.

Our results show that the electronic density of states at the interface depends crucially on the details of the local atomic structure. Therefore we have relaxed the atomic positions to minimize the forces on the ions. We compare two possible interface geometries, where the Pd atoms are placed on the Cu or O atoms of the CuO chains, respectively. For these configurations we determine the charge distribution across the interface.

TT 7.17 Mon 14:00 P1

Characterization of Top-Seeded Melt-Grown Bulk Superconductors by Hall Probe Mapping Techniques — •S. Haindl[1], H.W. Weber[1], N. Hari Babu[2], D. A. Cardwell[2], S. Meslin[3], J. Noudem[3], L. Shlyk[4], and G. Krabbes[4] — [1]Atomic Institute of the Austrian Universities, TU Vienna, Austria — [2]IRC in Superconductivity, University of Cambridge, UK — [3]CRISMAT-ENSICAEN, CNRS/UMR, France — [4]IFW Dresden, Germany

We report on the characterization of top-seeded melt-grown (TSMG) single grain bulk superconductors by two Hall probe mapping techniques. Scanning the trapped field distribution following magnetization of the sample in an external field is an established method of characterizing these materials. This technique enables both determination of the maximum trapped field after complete field penetration of the bulk sample, and identification of growth-induced inhomogeneities within the sample microstructure. A new mapping technique known as Magnetoscan has been developed over the past two years and recently improved to yield more useful information about the quality of bulk superconductors. This technique involves scanning simultaneously a small permanent magnet and a Hall probe over the unmagnetized superconducting surface of the bulk sample. Interesting results have been obtained using the magnetoscan technique, including direct imaging of different growth sectors in bulk samples and the identification of inhomogeneities such as cracks and grain-boundaries and the mapping of artificial holes in the single grain microstructure.

TT 7.18 Mon 14:00 P1

Nanometer-scale superconducting domains observed on $NdBa_2Cu_3O_{7-\delta}$ — •Pintu Das[1], Dirk Mautes[1], Michael R. Koblischka[1], Thomas Wolf[2], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, University of Saarbruecken, D-66041 Saarbruecken, Germany — [2]Forschungzentrum Karlsruhe GmbH, Instiitute of Solid State Physics, D-76021 Karlsruhe, Germany

In understanding high temperature superconductivity, the recent focus is at the local-scale electronic modulation and its influence towards superconductivity in general. The granular structure and atomic-scale modulation of the density of states in $Bi_2Sr_2CaCu_2O_{8+\delta}$ have been observed [1,2]. Here we report Scanning Tunneling Spectroscopic (STS) results obtained on the (ab) plane of a slightly underdoped $NdBa_2Cu_3O_{7-\delta}$ (T_c= 93.5 K) twinned single crystals at 4.2 K. Recent results proved that the NdBCO surface is highly clean and stable in air, showing atomic resolution at room temperature [3]. We used the STS imaging technique to study the electronic inhomogeneity and we observe that there are superconducting domains of $\sim$ 3 nm length scale separated by nonsuperconducting regions, similar to that observed in $Bi_2Sr_2CaCu_2O_{8+\delta}$. In the superconducting domains, the size of the energy gap spatially varies from $\sim$ 16 meV to $\sim$ 44 meV. The average gap size is found to be $\sim$ 22 meV. We discuss these data and the possible origin of the inhomogeneous electronic structure of the respective materials.

[1] Lang et al., Nature 415, 412 (2002)
[2] McElroy et al., Nature 422, 592 (2003)
[3] Ting et al., Appl. Phys. Lett. 72, 2035 (1998)

TT 7.19 Mon 14:00 P1

Nanoscale stripe structures in $SmBa_2Cu_3O_x$ superconductors — •M. Winter[1], M. R. Koblischka[1], Th. Wolf[2], X. Yao[3], A. Hu[4], and U. Hartmann[1] — [1]Institute of Experimental Physics, University of Saarbrücken, P.O.Box 151150, 66041 Saarbrücken, Germany — [2]Forschungzentrum Karlsruhe GmbH, Institute of Solid State Physics, D-76021, Karlsruhe, Germany — [3]Department of Physics, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai 200030, P. R. China — [4]Department of Physics, University of Waterloo, 200 Univ. Ave. West, Waterloo, ON N2L 3P7, Canada

AFM and STM scans on $SmBa_2Cu_3O_x$ (SmBCO) melt-processed samples prepared using different techniques revealed the presence of nanoscale stripe-like structures, sometimes parallel over several micrometers, sometimes wavy. These structures consist of chemical compositional fluctuations and act as effective δT_c pinning centers due to their wavelength of typically 10-60 nm which is comparable to the ideal pinning-center size of 2 ξ (10 nm for $YBa_2Cu_3O_x$ in the ab-plane). Compared to similar structures in ternary (Sm,Eu,Gd)$Ba_2Cu_3O_x$ (SEG) and (Nd,Eu,Gd)$Ba_2Cu_3O_x$ (NEG)) systems, where the stripes appear either as plateau-like stripes or as chains of aligned clusters, the stripes in SmBCO always appear as plateau-like stripes with a height of 1 Å- 8Å. These pinning structures throughout the whole sample volume may be a key

to improve critical current densities especially at high external magnetic fields.

TT 7.20 Mon 14:00 P1

How superstructure free is superstructure free Pb-BSCCO ? — •L. Dudy, B. Müller, B. Ziegler, A. Krapf, H. Dwelk, R.-P. Blum, C. Janowitz, and R. Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin

Pb- substituted BSCCO single crystals have been investigated by LEED and variable temperature VT- STM. While LEED pictures showed no superstructure spots in the range $30eV \leq E_{kin} \leq 320eV$, a closer look by VT- STM revealed that an ordered, alternating topographical formation of nano- domains with and without superstructure occurred. Independent of these geometrical nano- domains a long range ordering in the local density of states detected by corrugation analysis was also observed.

TT 7.21 Mon 14:00 P1

Unusual Nernst effect in various superconductors — •C. Hess[1], E. Ahmed[1], C. Falkenberg[1], D. Souptel[1], G. Behr[1], B. Büchner[1], U. Ammerahl[2], and A. Revcolevschi[2] — [1]IFW Dresden, Germany — [2]Laboratoire de Physico-Chimie des Solides, Université Paris-Sud, France

We present experimental results of the Nernst-effect in the normal state of various superconductors. In particular, we investigated the high temperature superconductor $La_2Sr_xCuO_4$ with and without Eu-doping. The Eu-ions suppress superconductivity and stabilize a stripe phase in the CuO_2-planes of the materials. We find that the relatively large Nernst-coefficient which has previously been reported for the normal state in pure $La_2Sr_xCuO_4$ is also present in the Eu-doped materials extending deep into the stripe ordered phase. We compare these results with the Nernst-effect of the superconductor YNi_2B_2C.

TT 7.22 Mon 14:00 P1

Rare earth substitutions and phase diagram studies in the ruthenocuprate system — •Eugenio Casini[1], Thomas P. Papageorgiou[2], Antonio Vecchione[3], Consiglia Tedesco[4], and Hans F. Braun[1] — [1]Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]HochFeld-Magnetlabor Dresden, Forschungszentrum Rossendorf, D-01314 Dresden, Germany — [3]INFM and Dipartimento di Fisica "ER Caianiello", Universitá di Salerno — [4]Dipartimento di Chimica, Università di Salerno, I-84081 Baronissi (Salerno), Italy

Coexistence of superconductivity and magnetism in the ruthenocuprate compounds has been the object of many investigations. $RuSr_2GdCu_2O_{8-\delta}$ is the most studied member of this class of materials and is the first and single known oxide in the quinary Sr-Gd-Ru-Cu-O system. Discording studies about the effect of the rare earth elements on the crystal structure and physical properties of these materials are reported. The formation of the $RuSr_2NdCu_2O_{8-\delta}$ compound is investigated following different preparation paths. Under standard conditions with the reported nominal composition a three-phase mixture is obtained. The concurring phases are indentified as: $(Sr_{1-x}Nd_x)(Ru_{1-x}Cu_x)O_y$, $Sr_2NdRuCuO_7$ and $(Sr_{14-x}Nd_x)Cu_{24}O_{41}$. A characterization of these compounds is carried out by XRD, DTA and EDX analysis whereas superconducting and magnetic properties are determined with ac and dc susceptibility measurements. Magnetic transitions in the temperature range 10-20K and 20-30K are detected for the $Sr_2NdRuCuO_7$ and $(Sr_{14-x}Nd_x)Cu_{24}O_{41}$ compounds, respectively. The $Sr_2NdRuCuO_7$ compound has not been previously reported.

TT 7.23 Mon 14:00 P1

Theory of magnetic excitations in bilayer cuprates — •Hiroyuki Yamase and Walter Metzner — Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, D-70569, Stuttgart, Germany

We calculate the dynamical magnetic susceptibility $\mathrm{Im}\chi(\mathbf{q},\omega)$ in the bilayer t-J model in slave-boson mean-field approximation. At low temperature, where the d-wave superconducting state is realized, a pronounced peak in $\mathrm{Im}\chi(\mathbf{q},\omega)$ appears at $\mathbf{q}=\mathbf{Q}=(\pi,\pi)$ and $\omega=\omega_{\mathbf{Q}}^{\mathrm{res}}$. For $\omega<\omega_{\mathbf{Q}}^{\mathrm{res}}$ strong spectral weight spreads around $\mathbf{Q}$, forming a diamond shaped pattern in $\mathbf{q}$-space. This spectral weight is due to a collective mode, known as "resonance mode" in the cuprates. The ω versus $\mathbf{q}$ dispersion of the mode is bent downwards around $\mathbf{Q}$. For $\omega>\omega_{\mathbf{Q}}^{\mathrm{res}}$, strong signals of $\mathrm{Im}\chi(\mathbf{q},\omega)$ tracing an upward dispersion are found. In the normal state, $\mathrm{Im}\chi(\mathbf{q},\omega)$ exhibits only a broad maximum at $\mathbf{q}=\mathbf{Q}$, that is incommensurate signals appear only in the d-wave pairing state. The above results hold in both odd ($q_z=\pi$) and even ($q_z=0$) channels. The most relevant experimentally observed features of magnetic excitations in bilayer cuprates are well captured by slave-boson mean-field theory.

TT 7.24 Mon 14:00 P1

Theory of the in-plane anisotropy of magnetic excitations in YBCO — •Hiroyuki Yamase and Walter Metzner — Max-Planck-Institute for Solid State Research, Heisenbergstrasse 1, D-70569, Stuttgart, Germany

A pronounced xy-anisotropy was observed in recent neutron scattering experiments for magnetic excitations in untwinned YBCO.[1] The relatively small anisotropy of the bare band structure due to the orthorhombic crystal symmetry seems to be enhanced by correlation effects. A natural possibility is that the system is close to a Pomeranchuk instability associated with a d-wave Fermi surface deformation (dFSD).[2,3] We investigate this possibility in the bilayer t-J model within a self-consistent slave-boson mean-field theory. We show that the dFSD correlations drive a pronounced xy-anisotropy of magnetic excitations at low doping and at relatively high temperatures, providing a scenario for the observed xy-anisotropy also in $YBCO_{6.6}$ and $YBCO_{6.5}$, and in the pseudogap phase. [1] V. Hinkov *et al.*, Nature **430**, 650 (2004). [2] H. Yamase and H. Kohno, J. Phys. Soc. Jpn. **69**, 332 (2000); **69** 2151 (2000). [3] C. J. Halboth and W. Metzner, Phys. Rev. Lett. **85**, 5162 (2000).

TT 7.25 Mon 14:00 P1

Theory of ultrafast nonequilibrium dynamics in superconductors — •Julia Unterhinninghofen[1], Andreas Knorr[1], and Dirk Manske[2] — [1]Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin — [2]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, 70596 Stuttgart

A theory of the dynamical ultrafast optical excitation of model superconductors is presented. We consider excitation of a nonequilibrium quasiparticle distribution via a femtosecond optical pulse and the subsequent scattering with optical phonons. The scattering processes lead to a recombination of the excited quasiparticles to equilibrated cooper pairs. Using the density matrix formalism, relaxation processes on a picosecond timescale and time-resolved pump-probe spectra are calculated.

TT 7.26 Mon 14:00 P1

Spin and Charge Josephson effects between non-uniform superconductors with coexisting helimagnetic order — •Ilya Eremin[1,2], Flavio S. Nogueira[3], and Rene-Jean Tarento[4] — [1]Max-Planck Institut für Physik komplexer Systeme, Nöthnitzerstr 38, D-01187 Dresden, Germany — [2]Institut für Mathematische/Theoretische Physik, Technische Universität Carolo-Wilhelmina zu Braunschweig, D-38106 Braunschweig, Germany — [3]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany — [4]Laboratoire de Physique des Solides, UMR 8502 - Université Paris-Sud, Bât. 510, F-91405 Orsay Cedex, France

We consider the spin and charge Josephson current between two non-uniform superconductors with helimagnetic order. We demonstrate that the presence of the helimagnetic phase generates a spin Josephson effect and leads to additional contributions to both single-particle and Josephson charge current. It is shown that for such systems the AC effect differs more radically from the DC effect than in the case of a BCS superconductor. The most interesting effect occurs in the presence of an external magnetic field and in absence of voltage, where we show that the charge Josephson current can be tuned to zero while the spin Josephson current is non-vanishing. This provides a well controlled mechanism to generate a spin supercurrent in absence of charge currents.

TT 7.27 Mon 14:00 P1

Enhancement of pairing due to the presence of resonant cavities — •K. Morawetz[1,2], B. Schmidt[1], M. Schreiber[1], and P. Lipavsky[3] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [3]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 5, 12116 Prague 2

A correlated fermion system is considered surrounding a finite cavity with virtual levels. The pairing properties are calculated and the influence of the cavity is demonstrated. To this end the Gell-Mann and Goldberger formula is generalized to many-body systems. We find a possible enhancement of pairing temperature if the Fermi momentum times

the cavity radius fulfills a certain resonance condition which suggests an experimental realization.

[1] K. Morawetz, M. Schreiber, B. Schmidt, P. Lipavský, Enhancement of pairing due to the presence of resonant cavities, Phys. Rev. B 72 (2005) 174504-1-5

[2] K. Morawetz, M. Schreiber, B. Schmidt, A. Ficker, P. Lipavský, Correlated two-particle scattering on finite cavities, Phys. Rev. B 72 (2004) 014301-1-15

TT 7.28 Mon 14:00 P1

Bernoulli potential in type-I and weak type-II superconductors: Electrostatic potential above the vortex lattice — •K. Morawetz[1,2], P. Lipavsky[3], J. Kolacek[4], E.H. Brandt[5], and M. Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [3]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 5, 12116 Prague 2 — [4]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic — [5]Max-Planck-Institute for Metal Research, 70506 Stuttgart, Germany

The electrostatic potential above the Abrikosov vortex lattice, is evaluated within the Ginzburg-Landau theory. Unlike previous studies we include the surface dipole. Close to the critical temperature, the surface dipole reduces the electrostatic potential to values below sensitivity of recent sensors. At low temperatures the surface dipole is less effective and the electrostatic potential remains observable as predicted earlier. We propose an experimental measurement by NMR to access this field which can yield informations about material parameters.

[1] P. Lipavský, K. Morawetz, J. Kolacek, J. J. Mares, E. H. Brandt, M. Schreiber, Bernoulli potential in type-I and weak type-II supercoductors: III. Electrostatic potential above the vortex lattice Phys. Rev. B 71 (2005) 024526-1-7, II. Surface dipole, Phys. Rev. B 70 (2004) 104518-1-7, I. Surface charge, Phys. Rev. B 69 (2004) 024524-1-7

TT 7.29 Mon 14:00 P1

Theory of Ultrafast Pump-Probe-Spectra of BCS-type Superconductors — •Sabine Körbel, Tilmann Kuhn, and Vollrath Martin Axt — Institut für Festkörpertheorie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Straße 10, 48149 Münster

Ultrafast optical excitation yields information about the microscopic interaction mechanisms in different materials. The theoretical description and modelling has been successfully carried out for semiconductors within the density-matrix-formalism. We applied the same formalism to the BCS-type superconductor. In particular we study the dynamical electrical conductivity after exciting the system by a picosecond pump pulse with an energy slightly above the superconducting gap. Our results show that the nonequilibrium dynamics of the gap is strongly correlated to the dynamics of the quasiparticles which are generated by the pump pulse, and their coherences. We show the influence of particle number and energy distribution on pump probe spectra.

TT 7.30 Mon 14:00 P1

Qualitative Modeling of the Quasiparticle Green's Function in Cuprates Based on ARPES Data — •Dmytro Inosov[1], Sergey Borisenko[1], Alexander Kordyuk[1,2], Volodymir Zabolotnyy[1], Jochen Geck[1], Andreas Koitzsch[1], Jeorg Fink[1], Martin Knupfer[1], and Bernd Büchner[1] — [1]Leibnitz-Institut für Festkörper- und Werkstofforschung, IFW-Dresden, P.O.Box 270116, D-01171 Dresden, Germany — [2]Institute of Metal Physics of National Academy of Sciences of Ukraine, 03142 Kyiv, Ukraine

ARPES data provides a detailed view of the renormalized band structure in cuprates and, consequently, is a key to the self-energy and the quasiparticle Green's function. However, due to the matrix elements and experimental specifics, comparison with the results provided by different experimental techniques is not straightforward. A model which would allow such a comparison with STM, INS, and RS data is proposed.

TT 7.31 Mon 14:00 P1

Effect of Zn and Ni impurities on the quasiparticle renormalization in Bi-2212 — •V. B Zabolotnyy[1], S. V. Borisenko[1], A. A. Kordyuk[1,2], J. Fink[1], J. Geck[1], A. Koitzsch[1], M. Knupfer[1], B. Büchner[1], H. Berger[3], A. Erb[4], C. T. Lin[5], and B. Keimer[5] — [1]Institute for Solid State Research, IFW-Dresden, Germany — [2]Institute of Metal Physics of National Academy of Sciences of Ukraine, 03142 Kyiv, Ukraine — [3]Institute of Physics of Complex Matter, EPFL, CH-1015 Lausanne, Switzerland — [4]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften,Walther-Meißner Strasse 8, 85748 Garching, Germany — [5]Max-Planck Institut für Festkörperforschung, D-70569 Stuttgart, Germany

The Cu substitution by Zn and Ni impurities and its influence on the mass renormalization effects in angle resolved photoelectron spectra (ARPES) of $Bi_2Sr_2CaCu_2O_{8-\delta}$ is addressed. We show that the nonmagnetic Zn atoms have much stronger effect both in nodal and antinodal parts of the Brillouin zone than magnetic Ni. The observed changes are consistent with the behaviour of the spin resonance mode as seen by inelastic neutron scattering in YBCO. This strongly suggests that the "peak-dip-hump" and the "kink"in ARPES on the one side and neutron resonance on the other are closely related features.

TT 7.32 Mon 14:00 P1

Azimuthal polarization dependence of x-ray absorption of Bi-2201 single crystals — •B. Müller, R. Mitdank, L. Dudy, J. Rasch, B. Ziegler, L. Lasogga, H. Dwelk, A. Krapf, C. Janowitz, and R. Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin

The hole concentration in the CuO_2-planes is one of the most important parameters of high-Tc superconductors and x-ray absorption spectroscopy (XAS) is well known to be an excellent experimental tool for its determination. For polycrystalline ceramic materials this has been demonstrated by analysing the so-called pre-peak at the $O1s - 2p$ absorption line [1] and a satellite line at the $Cu2p - 3d$ transition [2]. Also the single-CuO_2 layer superconductor Bi-2201 has been studied recently [3].

For single crystalline superconductors, on the other hand, likewise analyses gave completely non-systematic results. The reason for such an unexpected behavior is a distinct dependence of the absorption on the azimuthal polarization of the synchrotron radiation. A strong dependence on the polarization vector parallel and perpendicular to the surface is well known [1], but a dependence on orientation within the CuO_2-plane has not been considered so far.

[1] J. Fink et. al., Springer Series in Solid-State Sciences Vol. 91, 406 (1989)

[2] A.Q. Pham et. al., Phys. Rev. B 48, 1249 (1993)

[3] M. Schneider et. al., Phys. Rev. B 72, 014504 (2005)

TT 7.33 Mon 14:00 P1

Spin-Orbit Coupling Effects In The 3-Kelvin Phase Of Sr_2RuO_4 — •Florian Loder — Experimentalphysik VI, Universität Augsburg, D-86135 Augsburg

The inhomogeneous superconducting phase in the Sr_2RuO_4, called 3-Kelvin phase, has been shown to occur at interfaces between the bulk material and μm-size Ru-inclusions. It has been proposed that the interface region would be characterized by the strain-induced RuO_6 octahedra rotation around the c-axis. Here we show that this gives rise to a staggered antisymmetric spin-orbit coupling which in a homogeneous magnetic field induces both a uniform and a staggered spin component. This spin-orbit coupling influences the superconducting spin-triplet phase nucleating at the interface. A particularly interesting aspect is the possibility to induce a quasi particle gap in $\vec{Q} = (\pi, \pi, 0)$-nested Fermi surface by an applied magnetic field. This gives rise to an intriguing novel form of paramagnetic limiting and would explain the puzzling observation of the suppression of the upper critical field of the inhomogeneous 3-Kelvin phase.

TT 7.34 Mon 14:00 P1

Spectroscopic investigations on Na_xCoO_2 — •T. Kroll[1], A.A. Aligia [2], J. Geck[1], D. Hawthorn [3], C. Hess[1], T. Schwieger[1], G. Krabbes[1], C. Sekar[1], D. Batchlor[4], M. Knupfer[1], J. Berger[5], J. Fink[1], G.A. Sawatzky[3], and B. Büchner[1] — [1]IFW Dresden, P.O. Box 270016, D-01171 Dresden, Germany — [2]Centro Atomico Bariloche (CAB), Av. Bustillo 9500, 8400 S.C. de Bariloche, Argentina — [3]Advanced Materials and Process Engineering Laboratory (AMPEL), 2355 East Mall, Vancouver, BC, V6T 1Z4, Canada — [4]Universität Würzburg, Am Hubland, D-97074 Würzburg — [5]Institute of Physics of Complex Matter, EPFL, CH-1015 Lausanne, Switzerland

Since the discovery of superconductivity in 2003 in $Na_{0.3}CoO_2 1.3H_2O$ many investigations have been performed on these materials. In order to understand the physics behind the rich phase diagram of Na_xCoO_2 in more detail a good knowledge of its electronic structure is crucial. In this poster we present the results of different spectroscopic methods such as NEXAFS and XPS on a wide doping range for different temperatures and polarisation as well as cluster calculations which helps to understand the electronic structure of Na_xCoO_2.

TT 7.35 Mon 14:00 P1

Pressure-induced changes in the quasi-one-dimensional superconductor β-$Na_{0.33}V_2O_5$ studied by Raman spectroscopy — •S. Frank[1], C. A. Kuntscher[1], I. Gregora[2], T. Yamauchi[3], and Y. Ueda[3] — [1]1.Physikalisches Institut, Universität Stuttgart, D-70550 Stuttgart, Germany — [2]Institute of Physics ASCR, Praha, Czech Republic — [3]Institute for Solid State Physics, University of Tokyo, Tokyo

β-$Na_{0.33}V_2O_5$ is one of the first known inorganic quasi-one-dimensional superconductors. The pressure - temperature phase diagram is remarkable, showing a superconducting phase for pressures higher than 7 GPa in direct vicinity to a charge-ordered phase. The mechanism of the superconductivity and its relation to the charge ordering is not clear.

In a recent infrared study under pressure major changes in the reflectivity spectra were observed above 12 GPa, in particular the appearance of additional, relatively broad excitations [1]. A redistribution of charge with a possible relation to structural changes was suggested as a possible explanation. To obtain a deeper understanding of the changes occurring at 12 GPa we carried out polarization-dependent Raman spectroscopy under pressure at room temperature. The results are discussed in terms of a possible structural phase transition at 12 GPa.

Supported by the DFG, Emmy Noether-program.

[1] C.A. Kuntscher et al., Phys. Rev. B **71**, 220502(R) (2005)

TT 7.36 Mon 14:00 P1

Interaction corrections in Andreev reflection processes — •Markus Müller and Wolfgang Belzig — Universität Konstanz, Fachbereich Physik, D-78457 Konstanz, Germany

Understanding the conductance properties is of elementary interest when investigating electronic transport in nanostructures. We focus on the junction between a conventional superconductor and a normal metal. We consider a system of a one-dimensional weakly interacting electron gas on one and a superconductor on the other side, separated by a single potential localized in the interface region. Due to electron-electron interaction the Andreev reflection amplitudes are modified. A Poor Man's renormalization group procedure is used to handle logarithmic divergencies appearing in a perturbative treatment. Our approach is similar to the studies of conduction of a weakly interacting one-dimensional electron gas through a single barrier, realized by Matveev, Yue, and Glazman [Phys. Rev. Lett. **71**, 3351 (1993)]. The renormalized Andreev reflection amplitudes are calculated for any energy, and interface potentials of arbitrary strength. We discuss the temperature and voltage dependence of the Andreev conductance and compare with experimental results found by Morpurgo et al. [Science **286**, 263 (1999)]

TT 7.37 Mon 14:00 P1

Impact of the transport supercurrent on the zero-bias conductance peak — •Sergei Shevchenko and Alexander Omelyanchouk — Institute for Low Temp. Phys. and Eng., Lenin Ave. 47, 61108 Kharkov, Ukraine.

The impact of the supercurrent on the density of states in superconducting structures is investigated. Namely two situations were studied: (i) of a film containing a weak link and (ii) a film of a d-wave superconductor. In Ref. [1] we have shown that in the situation when the transport supercurrent flows in the region of suppressed order parameter (in the vicinity of the weak link as in the case (i) or at the boundary of a d-wave superconductor, case (ii)) the quasiparticles create the countercurrent. In this work we show that these quasiparticles are responsible for the appearance of the zero-bias conductance peak. Particularly we investigate the impact of the transport supercurrent flowing in parallel to the boundary on the conductance of the SIN-structure and discuss its observability with the scanning tunneling spectroscopy, as in Ref. [2]. We also discuss the relation of our results to the experiment, presenting alternative explanation of the experimental results of Ref. [2].

[1] Yu.A. Kolesnichenko, A.N. Omelyanchouk, and S.N. Shevchenko, Phys. Rev. B 67, 172504 (2003); Low Temp. Phys. 30, 213 (2004). [2] J. Ngai, P. Morales, and J.Y.T. Wei, Phys. Rev. B 72, 054513 (2005).

TT 7.38 Mon 14:00 P1

Proximity effect in superconducting MgB_2/Fe/MgB_2 trilayer — •B. Sahoo[1], W. Keune[1], V. Kuncser[2], A. I. Chumakov[3], and R. Rueffer[3] — [1]Fachbereich Physik, Universität Duisburg-Essen, Duisburg, Germany — [2]National Institute for Physics of Materials, Bucharest-Magurele, Romania — [3]European Synchrotron Radiation Facility, Grenoble, France

By Mössbauer spectroscopy (CEMS) we have observed, at about Tc, an anomaly in a annealed superconducting MgB_2(500 Å)/ ^{57}Fe(40 Å)/MgB_2(500 Å) trilayer (Tc = 25 K) in the T-dependence of the spectral center-line shift, which does not follow the usual Debye behavior. This anomaly is absent in a nonsuperconducting multilayer. We have not observed anomalies in the T-dependence of the magnetic hyperfine field, and also not in the ^{57}Fe phonon density of states (PDOS) measured by nuclear resonant inelastic X-ray scattering with 3 meV resolution. Hence the observed anomaly at Tc may be either due to the modification of the low-energy part (< 3 meV) of the PDOS (at present not accessible experimentally), or due to the change of the s-electron density at the ^{57}Fe nucleus, because of Cooper pair formation in the superconducting state.

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TT 7.39 Mon 14:00 P1

Proximity effect and multiple Andreev reflections in diffusive superconductor-normal-metal-superconductor junctions — •Jan C. Hammer[1], Juan Carlos Cuevas[1,2,3], Juha Kopu[1,4], Janne K. Viljas[1], and Matthias Eschrig[1] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, 28049-Madrid, Spain — [3]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe — [4]Low Temperature Laboratory, Helsinki University of Technology, P.O.Box 2200, FIN-02015 HUT, Finland

We present a theory of the current-voltage characteristics in diffusive superconductor-normal-metal-superconductor junctions. By solving the time dependent Usadel equation we are able to describe the phase-coherent transport for arbitrary length of the normal wire and arbitrary temperature. We show how the interplay between proximity effect and multiple Andreev reflections gives rise to a rich subgap structure in the conductance and how it is revealed in the non-equilibrium distribution function.

TT 7.40 Mon 14:00 P1

Diamagnetic screening properties of Nb/Ag and Nb/Ag/Fe layered structures — •C. Sürgers[1], H. Stalzer[1], A. Cosceev[1], and H. v. Löhneysen[1,2] — [1]Physikalisches Institut and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe, Germany

The diamagnetic properties of Nb/Ag and Nb/Ag/Fe layered structures of various thicknesses are investigated by means of SQUID and vibrating sample magnetometry. Data were taken for different temperatures in magnetic fields slightly tilted from the orientation parallel to the surface. For Nb/Ag double layers, below the diamagnetic transition of the Nb layer a second transition caused by the proximity-induced screening currents in the Ag layer is observed. Furthermore, a peculiar position dependence of the Ag magnetization signal is likely to be due to the missing formation of Andreev bound states along the lateral extensions of the film. While for Ag layers thicker than the coherence length or penetration depth of Nb an additional Fe layer on top of Ag destroys the coherence of Andreev pairs, the diamagnetic signal of Ag is recovered if the Ag layer thickness is strongly reduced. This is interpreted as being due to the competition of proximity-induced superconductivity by Nb

and pair breaking by Fe.

TT 7.41 Mon 14:00 P1

Superconducting Proximity Effect in $Co_2MnGe/V/Co_2MnGe$ Trilayers — •Dirk Sprungmann, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik,Ruhr-Universität Bochum, 44780 Bochum, Germany

We have studied the superconducting proximity effect in the trilayer system $Co_2MnGe/V/Co_2MnGe$. The motivation of this work was, whether the exchange field of the ferromagnetic Heusler alloy affects the critical temperature T_c in the same way as simple elementary ferromagnets do. For this purpose we measured the critical temperature T_c at different thicknesses of the V and the Co_2MnGe layers and determined the critical fields $H_{c\parallel}(T)$ and $H_{c\perp}(T)$ as a function of temperature. We applied the theory of Z. Radovic et al. and L.R. Tagirov to the data and obtained the coherence lengths of the pair wave function in the superconducting Vanadium ξ_s and in the ferromagnetic Heusler compound ξ_F. Additionally the theoretical fits provide the characteristic transparency parameters of the V/Co_2MnGe interface. The comparison of the experimental results and the theory reveals quantitative agreements with the classical proximity effect. However, quantitatively we also find inconsistencies in the parameters we have derived. This is due to the spin glass type of magnetic order for small thicknesses of the Co_2MnGe-phase, which is a complication compared to the classical proximity effect.
We acknowledge financial support through SFB 491.

TT 7.42 Mon 14:00 P1

Superconducting Spin Valve Effect of a V Layer Coupled to an Antiferromagnetic [Fe/V] Superlattice — •Dirk Sprungmann, Kurt Westerholt, Hartmut Zabel, R. Brucas, B. Hjörvarsson, D.A. Tikhonov, and I.A. Garifullin — Institut für Experimentalphysik/Festkörperphysik,Ruhr-Universität Bochum, 44780 Bochum, Germany

We have studied the superconducting properties of V-layers deposited on an antiferromagnetically coupled $[Fe_2V_{11}]_{20}$ superlattice (20 periods, 2 monolayers of Fe, 11 monolayers of V). The upper critical magnetic field $H_{c2\parallel}(T)$ for the direction parallel to the film plane exhibits an anomalous T-dependence for magnetic fields up to the ferromagnetic saturation field of the superlattice, indicating that the superconducting transition temperature T_S unambiguously depends on the relative magnetization orientation of the Fe_2 layers. This so called superconducting spin valve effect reaches up to 6% for the relative difference in T_S between the superlattice in ferromagnetic saturation and in the antiferromagnetic state and is more than one order of magnitude larger than observed in similar systems before. The shift proves, that the pair breaking effect of a ferromagnetic layer is reduced, if within the range of the superconducting correlation length another ferromagnetic layer with antiparallel spin orientation exists.
We acknowledge financial support through SFB 491.

TT 7.43 Mon 14:00 P1

Adiabatic pumping in a Superconductor-Normal-Superconductor weak link — •Michele Governale[1,2], Fabio Taddei[2], Rosario Fazio[2], and Frank Hekking[3] — [1]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]NEST-CNR-INFM & Scuola Normale Superiore, I-56126 Pisa, Italy — [3]LPMMC, CNRS & Université Joseph Fourier, BP 166, 38042 Grenoble CEDEX 9, France

Pumping consists in the transport of particles obtained by varying periodically in time some properties of a mesoscopic conductor[1].

We present a formalism to study adiabatic pumping between two superconducting terminals connected through a normal region, where charging effects are negligible (superconductor - normal -superconductor weak link). In this system, at low enough temperature, pumping is due to the adiabatic transport of Cooper pairs, and the pumped charge is related to the Berry phase accumulated, in a pumping cycle, by the Andreev bound states. We analyze in detail the case when the normal region is short compared to the superconducting coherence length. In this regime, the pumped charge turns out to be an even function of the superconducting phase difference. Hence, it can be distinguished from the charge transferred due to the standard Josephson effect.

[1] P.W. Brouwer, Phys. Rev. B **58**, R10135 (1998).

TT 7.44 Mon 14:00 P1

Magnetotransport in Lateral S/F/S Junctions — •Wilfried Meindl[1], Marco Aprili[2,3], and Christoph Strunk[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — [2]CSNSM-CNRS, Université Paris Sud, Orsay, France — [3]LPQ-ESPCI, 75005 Paris, France

The antagonism of superconductivity and magnetism is investigated by fabricating lateral superconductor/ferromagnet/superconductor junctions. Niobium strips connected by a bridge of the dilute ferromagnet PdFe were produced using shadow evaporation techniques. The length of the bridge varied between 200 and 600 nm and the Fe-concentration was 5 %. Measurements of the resistance as a function of an in-plane magnetic field show periodic oscillations, whose amplitude can reach up to 10% of the base resistance, and a hysteretic dip around zero. The oscillations appear close to the superconducting transition and vanish again at lower temperatures. The dip is associated with the magnetization reversal in PdFe.

TT 7.45 Mon 14:00 P1

Magnetotransport and Josephson Effect in Periodic Superconductor/2DEG Structures — •Franziska Rohlfing[1], Gustaaf Borghs[2], Dieter Weiss[1], and Christoph Strunk[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — [2]IMEC, Leuven, Belgium

We report on differential resistance measurements of arrays of multiple Josephson junctions as a function of out-of-plane and in-plane magnetic field. The junction array is made of 80 400 nm wide niobium stripes in 600 nm distance in good metallic contact with the two-dimensional electron gas in an InAs quantum well. The differential resistance shows oscillations in the out-of-plane magnetic field with an oscillation period determined by the area of a single junction. A trapezoidal modulation of the stripe width results in additional minima in the resistance at higher fields, indicative of a two-dimensional network of Josephson junctions. The supercurrent at 0.4 K is suppressed down to 10% by a parallel magnetic field on a scale of 20 mT, while a small fraction of the supercurrent survives up to 300 mT.

TT 7.46 Mon 14:00 P1

Fabrication of high stability shadow masks for complex hybrid structures — •Markus Gaass[1], Marco Aprili[2,3], Peter Tranitz[1], Werner Wegscheider[1], and Christoph Strunk[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg — [2]CSNSM-CNRS, Université Paris Sud, Orsay, France — [3]LPQ-ESPCI, 75005 Paris, France

We have developed and optimized a new thermostable mask system for shadow evaporation of refractory metals like Nb. The mask system consists of a PES sacrificial layer on which a 50nm thick Si_3N_4 film is deposited by PECVD at 275°C. The SiN is then covered with PMMA resist and patterned using conventional electron beam lithography and reactive ion etching with CHF_3. A free standing SiN-mask is created by removal of the PES with an isotropic etch in an oxygen plasma. The resulting masks are thermally and mechanically extraordinarily stable and show only minor deformations after deposition of 100nm Nb. This allows the fabrication of shadow masks for complex hybrid structures using angle evaporation techniques. We present first experiments on the magnetic response of superconducting loops with embedded ferromagnetic Josephson junctions using this technique.

TT 7.47 Mon 14:00 P1

Morphology of epitaxial $Al/AlO_x/Al$ trilayers — •Jonathan Eroms[1], H.W. Zandbergen[1], R. Delhez[2], A.H. Verbruggen[1], C.J.P.M. Harmans[1], and J.E. Mooij[1] — [1]Kavli Institute of Nanoscience Delft, TU Delft, The Netherlands — [2]Department of Materials Science and Engineering, TU Delft, The Netherlands

For increasing the Josephson junction quality in our superconducting qubit circuits we investigate growth of epitaxial aluminum films in a molecular beam epitaxy system. Here we present results on the crystalline structure of the bottom and top Al electrode in an $Al/AlO_x/Al$ layer stack. We monitor the growth in situ by RHEED and ex situ with x-ray diffraction and high-resolution TEM. The bottom Al layer can be grown epitaxially in (111) orientation on Si(111) surfaces. The Al surface is oxidized by introducing a low pressure of oxygen into the growth chamber, and an amorphous AlOx film is formed. Growing aluminum onto this layer still gives a (111) oriented film, but in different rotational orientations. Depending on the oxygen exposure, the top Al layer either

follows the orientation of the lower Al film, but with strong incorporation of twin crystals, or forms a random (111) texture.

TT 7.48 Mon 14:00 P1

Fabrication and characterization of Al/AlO_x based superconducting flux-qubits — •Martin Goeppl, Sonia Dandl, Tobias Heimbeck, Karl Madek, Matteo Mariantoni, Georg Wild, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, D-85748 Garching

Superconducting qubits based on superconducting loops containing an odd number of Josephson junctions with a coupling energy larger than the charging energy are called flux qubits. The qubit states are given by a symmetric superposition of currents flowing clockwise and counterclockwise when it is frustrated by applying a magnetic field corresponding to half a flux quantum in the loop. The system can be read out by a *dc* SQUID comprising the qubit.

We are fabricating flux qubits based on Al/AlO_x/Al tunnel junctions, using electron beam lithography and shadow evaporation technique. A crucial point was to establish and optimize the oxidation process for the lower electrode in order to fabricate Josephson junctions with well defined critical currents. Furthermore, the design of the electromagnetic environment is an important issue, which is required to isolate the qubit environmental sources of decoherence. Measurements on various test structures (Josephson junctions, SQUIDs, qubits) were used to analyze and further optimise the fabrication parameters.

This work is supported by the Sonderforschungsbereich 631 of the Deutsche Forschungsgemeinschaft

TT 7.49 Mon 14:00 P1

Fractional Josephson vortices as candidates for the observation of macroscopic quantum effects — •T. Gaber[1], E. Goldobin[1], K. Buckenmeier[1], K. Vogel[2], O. Crasser[2], R. Walser[2], W. P. Schleich[2], D. Koelle[1], and R. Kleiner[1] — [1]Physikalisches Institut, Experimentalphysik II,Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen — [2]Universität Ulm, Abteilung Quantenphysik, D-89069 Ulm

It is established experimentally that in long Josephson junctions (LJJ), where the phase dynamics can be mapped to the sine-Gordon equation with phase discontinuities, fractional vortices can appear spontaneously. In contrast to fluxons which are solitons and can move freely along LJJs, fractional vortices are pinned at the discontinuities and may have positive or negative polarity. They are useful for information encoding and are similar to spin-$\frac{1}{2}$ systems. In contrast to fluxon based devices, a fractional vortex can represent the ground state of the system which makes it more robust.

Fractional vortices, fractional vortex molecules and vortex crystals are interesting systems to study macroscopic quantum effects. We discuss the quantum properties of a single fractional vortex in a 0-π LJJ and a two-fractional-vortex molecule in a 0-π-0 LJJ and give an estimation of the crossover temperature in typical experiments. Several possibilities to construct and manipulate the quantum states of one or more vortices are presented. Possible readout schemes using integer fluxons and/or RSFQ logic are discussed.

TT 7.50 Mon 14:00 P1

Current and phase distribution in Josephson junctions with ferromagnetic interlayer — •Martin Weides[1], Dietmar Doenitz[2], Hermann Kohlstedt[1,3], Dieter Koelle[2], and Reinhold Kleiner[2] — [1]Institute for Solid State Research, Research Centre Juelich, Germany — [2]Physikalisches Institut - Experimentalphysik II, Universität Tübingen — [3]Department of Material Science and Department of Physics, University of Berkeley, USA

We use Low Temperature Scanning Electron Microscopy (LTSEM) to image current and phase distribution in low-T_C SINFS Josephson junctions (JJ) with diluted ferromagnetic $Ni_{60}Cu_{40}$ used as F-interlayer. Our technology [1] enables us to fabricate high quality junctions with low parameter spread. The configuration of magnetic domains in the F-interlayer is, amongst others, determined by the shape-anisotropy. The in-plane magnetization forms magnetic domains, which influence Cooper pair and quasiparticle transport trough the F-interlayer. We use annular and elliptical junction geometries for this work.
The imaging is based on the electron-beam-induced local heating of a resistively biased junction [2]. The beam-induced voltage-change is detected by Lock-In technique and is proportional to the Josephson current. The interaction between the local magnetic configuration of the JJ and external magnetic fields with respect to the transport current is studied.
[1] Weides et al., to appear in Physica C
[2] R. Gross and D. Koelle, Reports on Progress in Physics 57 (1994)

TT 7.51 Mon 14:00 P1

Internal Dissipation of Silicon at Cryogenic Temperatures — •Ronny Nawrodt[1], Anja Zimmer[1], Sandor Nietzsche[1], Wolfgang Vodel[1], Tina Clausnitzer[2], Ernst-Berhard Kley[2], Andreas Tünnermann[2], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, D-07743 Jena — [2]Friedrich-Schiller-Universität Jena, Institut für Angewandte Physik, Albert-Einstein-Strasse 15, D-07745 Jena

Internal dissipation at a certain temperature is the origin of thermal noise. Optical interferometric gravitational wave detectors are sensitivity limited by the thermal noise of their optical components (e.g. end mirrors, cavity couplers, beam splitters). The main contributions to this noise are due to the substrate, the optical coating, and the suspension. The thermal noise can be reduced by cooling to cryogenic temperatures. In addition the overall mechanical quality factor as a measure of dissipation should preferable increase at low temperatures. The experimental details of a new cryogenic apparatus for investigations of the temperature dependency of the dissipation of different substrate materials in the range of 5 to 300 K are presented. The main focus is on silicon as a well suited material for cryogenic optics due to its special low temperature properties. Results on Si[100] and Si[111] are presented and discussed.

This work is supported by the German DFG under contract SFB TR7.

TT 7.52 Mon 14:00 P1

Characterization and Noise-Measurements on HTSC-Flip-Chip-Gradiometers with Different Antennas — •Tobias Foerster[1], Henrik Schneidewind[2], Christoph Becker[1], Veit Grosse[1], Ralf Bechstein[1], Frank Schmidl [1], and Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, D 07743 Jena — [2]Institut für Physikalische Hochtechnologie e.V.(IPHT), Bereich Magnetik-Quantenelektronik, Albert-Einstein-Straße 9, D 07745 Jena

To optimize our HTSC-dc-SQUID gradiometric sensors with galvanically coupled antennas we investigated the performance of antennas on a separate substrate. These antennas are connected to a dc-SQUID-gradiometer in a Flip-Chip-Configuration.

Different combinations of thin-film and substrate materials, like TBCCO on Al_2O_3 or $LaAlO_3$ and YBCO on $SrTiO_3$, were used to produce antennas with variable layouts. The antennas were characterized concerning their critical current densities, critical temperature and noise properties to demonstrate their suitability for high resolution magnetic measurements in a Flip-Chip-Configuration.

Field-Gradient-Resolution and noise properties of multiple Flip-Chip-Sensors where then determined and compared.

TT 7.53 Mon 14:00 P1

Microwave power distribution in the near-field regime of a 98 GHz source — •Felix Stewing, Andre Kaestner, and Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Straße 66, 38106 Braunschweig

A new method for measuring microwave near-field radiation is presented. We use a scanning microscope equipped with a high-T_C Josephson-cantilever of $LaAlO_3$ to measure near-field power distributions in three dimensions with 100 nm spatial resolution. The height approach is piezo-controlled with a resolution of a few micrometers in z-direction (perpendicular to the surface).

First results are presented for high-frequency properties and possible spatial resolution of the Josephson cantilevers. The influence of the dielectric material $LaAlO_3$ on the measured microwave radiation pattern from a source of 98 GHz is investigated. The calculated and measured electromagnetic power distributions are compared.

TT 7.54 Mon 14:00 P1

Magnetic calorimeters for a direct neutrino mass measurement using ^{187}Re β decay — •Loredana Gastaldo[1], Daniel Haug[1], Markus Linck[1], Andreas Burck[1], Hannes Rotzinger[1], Andreas Fleischmann[1], Christian Enss[1], Viatcheslav Zakosarenko[2], Ronny Stolz[2], Jürgen Kunert[2], and Hans-Georg Meyer[2] — [1]Kirchhoff Institute for Physics, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany — [2]Institute for Physical High Technology, Albert-Einstein-Str. 9, D-07745 Jena, Germany

Metallic magnetic calorimeters (MMC) with Au:Er sensors are used as particle detectors in several research fields like absolute activity measurements of radioactive isotopes, high resolution x-ray spectroscopy and material analysis. The typical energy resolution of MMCs is in the range of few eV at 6 keV, which makes them promising candidates to detect the electrons emitted by ^{187}Re, whose end point energy of the continuous spectrum is about 2.5 keV. The analysis of the ^{187}Re spectrum is nowadays the only competitive technique for direct neutrino mass search besides KATRIN (KArlsruhe TRItium Neutrino experiment) investigating tritium β decay. The work presented describes the development of a MMC configuration that is suitable to detect the β decays occurring in a superconducting rhenium absorber. The detector is based on a gradiometric SQUID with integrated meander-shaped pickup coil. We discuss the general performance of the detector, the thermalization times, the noise contributions and the observed energy resolution.

TT 7.55 Mon 14:00 P1

Large area metallic magnetic calorimeters for ^{36}Cl absolute activity measurement — •M. Linck[1], A. Burck[1], E. Leblanc[2], M. Loidl[2], H. Rotzinger[1], T. Scarbrough[1], A. Fleischmann[1], and C. Enss[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Germany — [2]Laboratoire National Henri Becquerel, CEA Saclay, France

The measurement of the activity and the energy spetrum of α and β emitting radioactive sources is of great importance in a large number of field ranging from medicine to the characterization of nuclear waste. At the same time the limitations of conventional detector techniques make this effort a highly non-trivial problem in radion metrology. Usually a number of techniques has to be combined including liquid scintilation detectors which are known for their poor energy resolution and energy dependent quantum efficiency. We have developed a detector based on a metallic magnetic calorimenter (MMC), with a metallic absorber that covers the full solid angle of 4-π around the source. Because of the calorimetric principle it has equal sensitivity for α, β and γ radiation and a quantum efficiency of nearly 100%. The MMC is based on a planar Au:Er Sensor and a meander-shaped pickup coil. We will show the data of a first experiment measuring the decay of ^{36}Cl and compare the result to the theoretically expected spectrum for this second order forbidden β^--decay. We discuss the observed contributions to the noise, the quantum efficiency and the achieved energy resolution.

TT 7.56 Mon 14:00 P1

Study of superconducting and magnetic microcalorimeters for a high sensitivity neutrino mass measurement experiment — •Loredana Gastaldo[1,2] and Daniel Haug[1] — [1]Kirchhoff Institute for Physics, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany — [2]University and INFN Genoa, Via Dodecaneso 33, I-16146 Genoa, Italy

Since the neutrino oscillation experiments have proved that neutrinos are massive particles, the question if it is possible to determine its absolute value can be addressed with a very high precision β decay experiment. An international collaboration is growing around the project of Microcalorimeter Arrays for a Rhenium Experiment (MARE) for measuring the neutrino mass with a sensitivity of about $0.2eV/c^2$. Here we present the status of the development of superconducting and magnetic low temperature microcalorimeters for the detection of ^{187}Re beta decay.

TT 7.57 Mon 14:00 P1

Commensurability and ratchet effects in Nb thin films with artificial pinning site — •M. Kemmler[1], C. Gürlich[1], H. Pöhler[1], M. Siegel[2], M. Neuhaus[2], R. Kleiner[1], and D. Koelle[1] — [1]Physikalisches Institut - Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen — [2]IMS, Universität Karlsruhe, Hertzstr. 16, D-76187 Karlsruhe

We investigate artificial pinning arrays - formed by (sub-) micron-sized holes (antidots) of various shape in Nb thin films. For measurements of electric transport and low-frequency noise we use a highly sensitive liquid Helium-cooled dc SQUID amplifier. The sample temperature is controlled and stabilized close to the Nb transition temperature T_c via an optical, essentially noiseless heating system. Measurements of critical current I_c vs. magnetic flux density B close to T_c reveal pronounced matching effects, i.e. an enhancement of I_c when the flux line lattice is commensurate with the antidot lattice. We also find such matching effects in the low-frequency flux noise, i.e. a suppression of the flux noise at the matching fields. By reshaping the artificial pinning sites it is possible to construct Abrikosov-vortex-ratchets [1,2]. For our measurements of ratchet effects triangular antidots are used. Measurements of the vortex response to an ac current drive reveal pronounced voltage rectification. We find a strong dependence of the voltage output on temperature, ac current amplitude and the magnetic field.

[1] J. Van de Vondel et al., Phys. Rev. Lett. **94**, 057003 (2005) .
[2] J. E. Villegas, et al., Science **302**, 1188 (2003).

TT 7.58 Mon 14:00 P1

Polarised neutron scattering on the flux line lattice (FLL) in Niobium — •Sebastian Mühlbauer[1], Robert Georgii[2], and Peter Böni[1] — [1]Physikdepartment E21, TU-München, 85747 Garching — [2]ZWE FRM-II, 85747 Garching

Recent polarised small angle neutron scattering (SANS) measurements of the flux line lattice (FLL) of superconducting niobium, performed on the SANS-2 at GKSS and on MIRA at the FRM-II showed clear polarisation dependent scattering, similarly measured by [1,2], that cannot be explained by means of the ideal model of the FLL. In ideal isotropic superconductors no spin dependent scattering occurs, because the flux lines are orientated parallel to the applied magnetic field B as well as the polarization of the neutrons is parallel to B [3]. Spin dependent scattering only occurs either i) assuming a non zero nuclear scattering length distribution with the same periodicity as the FLL (interference term) corresponding to the pinning centres or ii) assuming an individual bending of the flux lines, ruling out the geometrical constraint $B \parallel FLL$. We present new results, obtained by means of polarised neutron scattering on several niobium samples of a different residual resistivity ratio (RRR) and hence different pinning properties. These measurements were conducted on the cold spectrometer MIRA at the FRM-II in Garching.

[1] K. Neumann, et al, Eur. Phys. J. B **1**, 5-9, (1998)
[2] Experimental Report 5-51-229
[3] E. M. Forgan, et al., Physica B **267-268**, 115 (1999)

TT 7.59 Mon 14:00 P1

Vortex Matching in Niobium Films with Periodic Pinning Arrays produced by Micellar Technique — •M. Oettinger[1], J. Eisenmenger[1], C. Steiner[1], C. Pfahler[1], S. Brieger[1], A. Plettl[1], A. Dietrich[1], B. Koslowski[1], H.-G. Boyen[1], A. Ethirajan[1], P. Walther[2], and P. Ziemann[1] — [1]Abteilung Festkörperphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Zentrale Einheit Elektronenmikroskopie, Universität Ulm, D-89069 Ulm, Germany

An enhanced stability of a vortex lattice is expected whenever it matches a regular array of pinning centers without disturbing its preferred triangular order. The observation of such matching effects is challenging at temperatures much smaller than the critical temperature since artificial pinning centers should have sizes of a few nanometers, i.e. comparable to the coherence length, and should be periodically arranged. For the preparation of a triangular lattice of artificial pinning centers we first prepare a closed packed monolayer of $HAuCl_4$ loaded inverse micelles of diblock-copolymers onto a substrate. By applying a H-plasma the micelles are transformed into a triangular lattice of Au particles with diameters $\approx$ 10 nm. The particles serve as an etching masks for patterning arrays of pillars into the surface of a Si substrate. In a Nb thin film grown on top, pinning centers are formed at the pillars. Clear matching effects are observed even at temperatures much lower than the critical temperatures. Moreover an unusual "second"critical current is observed, indication two very different types of pinning mechanisms: Strong pinning on artificial pinning centers and weaker pinning by natural, randomly positioned pinning centers and "caging"in interstitial regions.

TT 7.60 Mon 14:00 P1

Enhancement of the vortex pinning in superconducting MgB_2 films — •Anatolie Sidorenko[1,2,3], Vladimir Zdravkov[1,2], Christian Leierer[2], Andreas Heinrich[2], Siegfried Horn[2], Reinhard Tidecks[2], Achim Wixforth[2], Thomas Koch[3,4], and Thomas Schimmel[3,4] — [1]IAP, LISES, ASM, Kishinev, Moldova — [2]IP, Universität Augsburg, Germany — [3]AP, Universität Karlsruhe, Germany — [4]INT, Forschungszentrum Karlsruhe, Germany

Superconducting MgB_2 films have extremely high critical current density, up to $j_c \sim 10^7/cm^2$ at 15 K in zero magnetic field what makes this novel superconductor very attractive for technical applications. But magnesium diboride exhibits a rapid loss of the current carrying capabilities in strong magnetic fields, caused by thermomagnetic instabilities leading to a rapid decrease of the activation energy for magnetic flux motion for $U_0(B)$ in fields of $B > 1$ Tesla. There are two possible ways to solve the problem of the too low pinning force for high magnetic fields: a) by covering the MgB_2 film with an electronicly isolated highly thermoconducting metallic layer to prevent thermomagnetic instabilities; b) by embedding artificial pinning centers within the film to increase the pinning force and thus the activation barrier for thermally activated flux flow. In the present work we report about the results of our experiments where we used both ways: a) coating of the MgB_2 film with Cu-layers ($0.3\mu m - 1.0\mu m$ thick) for thermo stabilization; b) the adsorption of ferromagnet nanoparticles (10nm - 50nm Fe and Ni particles) on the surface of the MgB_2 film.

TT 7.61 Mon 14:00 P1

Granularity and Spontaneous Vortex State for the Weakly Ferromagnetic Superconductor $RuSr_2GdCu_2O_8$ — •Thomas P. Papageorgiou[1], Ennio Casini[2], Hans F. Braun[2], Thomas Herrmannsdörfer[1], Andrea D. Bianchi[1], and J. Wosnitza[1] — [1]Hochfeld-Magnetlabor Dresden, Forschungszentrum Rossendorf, D-01314 Dresden, Germany — [2]Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany

In the high-T_c cuprate $RuSr_2GdCu_2O_8$ (Ru1212) weak ferromagnetism ($T_N^{Ru} \simeq 130$ K) coexists with superconductivity ($T_{c,onset} \simeq 50$ K). This rises the interesting question concerning the formation of a spontaneous vortex state (SVS) in the case that the internal magnetic field is greater than the first critical field H_{c1}. Recently, the formation of a SVS has been proposed for Ru1212 after the phase diagram for this compound was constructed from dc-magnetization and resistance measurements [1]. We show, by a comparison of resistance with ac-susceptibility and dc-magnetization measurements, where both the intra- and inter-granular superconducting transition are obvious, that the granular nature of the investigated samples has to be carefully considered in the investigations of possible SVS formation. A particular SVS with vortices pinned in the intergrain area is much more likely. Single crystals would be required to unambiguously demonstrate the formation or non-formation of a spontaneous vortex state in bulk Ru1212.

[1] C. Y. Yang, B. C. Chang, H. C. Ku, Y. Y. Hsu, cond-mat/0507014

TT 7.62 Mon 14:00 P1

Evidences for Flux Line Termination Inside of a Highly Anisotropic Superconductor: A Magnetic Force Microscopy Study — •Ung Hwan Pi[1], Alexander Schwarz[1], Marcus Liebmann[2], Zheong Gu Khim[3], Dong Ho Kim[4], and Roland Wiesendanger[1] — [1]University of Hamburg, IAP, Jungiusstr. 11, 20355 Hamburg — [2]Present Address: RWTH Aachen, Department of Physics, 52056 Aachen — [3]School of Physics, SNU, Seoul 151-742, South Korea — [4]Dept. of Physics, Yeungnam University, Kyungsan, South Korea

In highly anisotropic layered superconductors like $Bi_2Sr_2CaCu_2O_{8+\delta}$, the Josephson coupling between each layer is so weak that the phase coherence in c-direction is negligible and the termination of the flux line inside the sample is not forbidden by topology of the phase. Mints *et al.*[1] have reported in a theoretical study that the termination of the flux line inside the sample is energetically favorable for small enough samples. Our magnetic force microscopy study performed on the $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystal showed some evidences supporting this prediction. Since all flux lines have single flux quantum, they should exhibit the same contrast. However, we could observe a somewhat weaker contrast at several flux lines near an antiphase boundary. Two weak-contrast flux lines sometimes merged into one flux line with a stronger contrast. These weak magnetic contrasts are possible candidates for flux lines terminating beneath the sample surface.

[1] G. Mints *et al.* Phys. Rev. B **61**, 1623 (2000).

TT 7.63 Mon 14:00 P1

The transverse sound propagation in the superfluid helium inside carbon nanotube — •Vilchynskyi Stanislav and Tkachenko Olena — Kiev national Taras Shevchenko university

In the present work it was shown that it is possible of the propagation of the transverse quantized sound in superfluid helium inside carbon nanotube. This sound are caused of the geometrical parameters of the helium system and dynamical characteristic of the vortex thread in superfluid helium

TT 7.64 Mon 14:00 P1

Study the dependence between the pair interaction potential in the Bose liquid ^{4}He and and quasiparticle spectrum of superfluid ^{4}He at $T = 0$ — •Vitaliy Bardic and Stanislav Vilchynskyi — Kiev national Taras Shevchenko university

As well known the multiparticle collective effects in the Bose liquid lead to an essential renormalization of the pair interaction between atoms of superfluid helium. Self-consistent numerical calculations of the boson self-energy, polarization operator, pair order parameter, and quasiparticle spectrum of superfluid ^{4}He at $T = 0$, involving an iteration scheme with the single fitting parameter—the value of the repulsion potential at $r = 0$, have allowed us to find conditions for the theoretical spectrum $E(p)$ to coincide with the experimentally observed elementary excitation spectrum in ^{4}He. It is shown that the roton minimum in the quasiparticle spectrum $E(p)$, which corresponds to a maximum in the structural formfactor $S(q)$ of a Bose liquid, is directly associated with the first negative minimum of the Fourier component of the renormalized potential $\tilde{V(p)}$ of the pair interaction between bosons.

TT 7.65 Mon 14:00 P1

The Kinetics Asymmetry of the BCC-HCP Phase Transition in Solid Helium-4 — •Yegor Vekhov, Nikolay Mikhin, Andrey Polev, Eduard Rudavskii, and Alexandr Birchenko — B.Verkin Institute for Low Temperature Physics and Engineering, 47 Lenin Ave., Kharkov 61103 , UKRAINE

The subject of research is a solid helium-4. Samples were made by blocking capillary technique. The kinetics of the BCC-HCP structure phase transition was investigated by precise pressure measurement under constant value. The precision of pressure measurement is about 3 mbar and of temperature one is about 5 mK. During step wise temperature changes, within one phase (BCC or HCP), pressure change is described by one-exponential time dependence. During step wise cooling of the sample from the BCC region to the HCP it was found the pressure, at first, is decreasing to the extent of thermal compression of the overcooling BCC phase then, after some delay (5-500 s), the pressure is relaxing once again that is accompanied by a heat generation. The second stage of the pressure relaxation is described by superposition of two exponential dependences with short time constant (1-3 s - directly the BCC-HCP transition) and with long time constant (5-10 s - the relaxation process of defects which were formed during lattice rebuilding). During the inverse HCP-BCC phase transition the delay is practically not observed that can be explained by less BCC nucleation energy [1,2].

[1] T.A.Johnson and C.Elbaum, J. Low Temp.Phys., 107, 317 (1997). [2] Y.Okuda, H.Fujii, Y.Okumura, and H.Mackana, J. Low Temp.Phys., 121, 725 (2000).

TT 7.66 Mon 14:00 P1

Light scattering on an N-component Bose-Einstein condensate in an optical lattice — •Oleksandr Fialko, Christopher Moseley, and Klaus Ziegler — Universität Augsburg, Universitätsstr. 1,D-86135 Augsburg, Germany

We consider an N-component system of strongly interacting bosons in an optical lattice. On each lattice site a boson can occupy one of N different states. Tunneling is possible between neighboring lattice sites and different states. For this model we calculate the static structure factor and the density-density correlation function, both for zero and finite temperatures,in the limit $N \to \infty$ and in a $1/N$ expansion to study the properties of the BEC and the Mott-insulating phase.

TT 7.67 Mon 14:00 P1

Low-temperature investigation on thermal properties of glasses — •Astrid Netsch[1], Sabine Wolf[1], Hsin-Yi Hao[2], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg, Germany — [2]Jet Propulsion Laboratory, California Institute of Technology. Pasadena, California 91103, USA

The thermal conductivity of glasses at temperatures below 1 K is generally described by phononic thermal transport. The mean free path of the phonons is limited by scattering processes between heat-carrying phonons and tunneling systems. It seems plausible that mutually interacting tunneling systems can also contribute to thermal transport in glasses. This additional transport channel is supposed to be extremely small compared to the phononic contribution. We have performed experiments on the thermal conductivity of a glass capillary array which contains holes on a triangular lattice that serve as extra scatterers for thermal phonons. For measuring thermal conductivity of such diminutive magnitude, our contact-free technique has proven to be a suitable choice because of its extremly small parasitic heating. Our results show a thermal conductivity which varies roughly with T^3 down to about 50 mK as expected for boundary scattering of phonons. Below this temperature, the thermal conductivity deviates from this dependence and follows a weaker power law. So far it is not clear whether this deviation is caused by a non-phonon contribution to the thermal transport in glasses, or if a cross-over regime occurs in which the wave length of the thermal phonons becomes comparable with the lattice constant of the array of holes.

TT 7.68 Mon 14:00 P1

Dielectric polarisation echos on partially deuterated organic glassformers — •Marek Bartkowiak[1], Masoomeh Bazrafshan[1], Herbert Zimmermann[2], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kichhoff-Institut für Physik, Universität Heidelberg, Germany — [2]Max-Planck-Institut für medizinische Forschung, Heidelberg, Germany

The properties of amorphous solids are governed by tunnelling systems, at temperatures below a few Kelvin. Ever since tunnelling processes were considered to describe the anomalous low temperature behaviour of glasses the question about their microscopic origin is posed. Newly discovered magnetic field effects in the dielectric properties of glasses containing atoms with nuclear quadrupole moments have opened a path to a possible microscopic theory of tunnelling processes in amorphous materials. Recent studies of the magnetic field dependence of polarisation echos generated in partially deuterated glycerol have provided first insights regarding the tunnelling motion of glycerol molecules. We have now extended our investigations towards other organic glassformers. We present first data and discuss possible conclusion about the microscopic nature of tunnelling systems in these materials.

TT 7.69 Mon 14:00 P1

Quantum oscillations of thermoelectric force in quasi-two-dimensional conductors — •Danica Krstovska and Olga Galbova — Faculty of Natural Sciences, Department of Physics, P. O.Box 162, Skopje, Macedonia

The dependence of the thermoelectric force transverse to the layers in a layered conductor with a quasi-two-dimensional electron energy spectrum on the magnitude and orientation of the strong magnetic field in relation to the layers is theoretically analyzed. Giant quantum oscillation of the thermoelectric field versus 1/H, have been predicted, which will facilitates the experimental study of quantum oscillatory effects. It is shown that when the temperature gradient is directed along the normal n to the layers, the amplitude of the quantum oscillations substantially exceeds the smoothly varying part of the thermoelectric force transverse to the layers. This quantum oscillation effect can be used to a high degree of accuracy as a good spectroscopic method for experimental study of the characteristics of the Fermi surface of layered conductors.

TT 7.70 Mon 14:00 P1

Effect of H_2 and D_2 impurities on the structure and properties of solid Ne. Phase diagram of binary system Ne-nD_2 — •Nikolay Galtsov, Prokhvatilov Anatolii, and Strzhemechny Mikhail — Verkin Institute for Low Temperature Physics and Engineering of NAN Ukraine, 47 Lenin ave., Kharkov, 61103, Ukraine

Solid solutions of normal hydrogen and deuterium with neon, quench deposited from gas mixtures, were studied by powder x-ray diffraction for hydrogens contents from 2 to 70 mol.-% at temperatures from 5 K to melting temperatures. The structure of Ne-nH_2 and Ne-nD_2 condensates was investigation immediately after preparation. The boundary of homogeneous cubic hydrogen-in-neon solutions has been established to be about 2 mol-%, deuterium-in-neon - to be about 5 mol-%, under the specific sample preparation conditions. At higher nominal H_2 (D_2) concentrations, a hexagonal hcp_2 phase in addition to the cubic *fcc* phase forms. The volumes of the elementary cells of both phases are close to that of pure neon. The phase hcp_2 seems to be a perfect storage of hydrogen and deuterium: it can contain up to 85 mol.-% H_2 and up to 60 mol-% D_2. The hcp_2 disappeared as the condensates were warmed up to the melting temperatures. The metastable hexagonal phase observed in neon-rich mixtures studied here is apparently identical in nature to that found previously in hydrogen-rich mixtures: both hexagonal phases have roughly the same lattice parameters. The phase boundaries have been established for the entire entration range and proposed a full of phase diagram Ne-nD_2.

TT 7.71 Mon 14:00 P1

Thermal Conductivity of Solid Ethanol in the Three Polymorphous Phases — •Alexey Yushchenko, Alexander Krivchikov, Korolyuk Oksana, Gorodilov Boris, and Manzhelii Vadim — B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Solid ethyl alcohol can be obtained in three metastable long-living phases - position glass, an orientationally-disordered (static disorder) crystal (orientational glass) and a crystal with dynamic orientational disorder. The orientationally - ordered monoclinic - system crystal is the only thermodynamically equilibrium solid phase of the alcohol.
In this work the temperature dependence of the thermal conductivity of solid ethanol was measured in all solid phases under equilibrium vapor pressure at 2-159 K by the steady-state potentiometric method. The glass phase was obtained by cooling the container with liquid nitrogen at an extremely high rate (over 50 K/min). The orientationally - disordered bcc crystal phase was formed on hardening the slowly overcooled liquid at T = 125 K. An orientationally - ordered crystal evolved in the process of rapid crystallization provoked by heating the bcc phase to over 116 K. The recrystallized sample was then annealed for several days at a temperature close to the melting point.
Obtained data have been analyzed in the borders of the soft potential model.

TT 7.72 Mon 14:00 P1

Thermal conductivity of gas clathrate hydrates at low temperatures — •Olesya Romantsova, Alexander Krivchikov, Gorodilov Boris, Korolyuk Oksana, and Manzhelii Vadim — B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Clathrate hydrates are open polymorphous crystal structures related to ordinary ice. However, $\kappa(T)$ of gas hydrates is similar to glass. The understanding of the causes responsible for the glass-like behavior in gas hydrates will be helpful in finding a microscopic mechanism of the thermal transport in disordered solids.
The thermal conductivity of the THF and xenon hydrates has been measured using the steady-state technique in the intervals 2-220 K and 2-170 K, respectively. Two samples of THF hydrate were grown in the measuring cell during 7 min (fast cooling) and 70 min (slow cooling). For the sample of THF hydrate (slow cooling) in the interval 15-97 K and for xenon hydrate in the interval 56-97 K the behavior of $\kappa(T)$ shows an anomaly: the thermal conductivity decreases by almost over 50 per cent as the temperature increases. This observation is attributed to the consequence of resonant scattering where the coupling of the lattice with "rattling" motions of Xe dominates the thermal resistivity at high temperature. The thermal conductivity in the low temperature regime is found to follow the prediction of the soft-potential model. The comparative analysis of the thermal conductivities of two hydrates with different guest molecules can provide new information about the mechanisms of phonon scattering in crystal hydrates.

TT 7.73 Mon 14:00 P1

Electron diffraction study of clusters formed in a supersonic jet of Ar-Kr gas mixture — •Oleksandr Danylchenko, Spartak Kovalenko, and Vladimir Samovarov — B. Verkin Institute for Low Temperature Physics and Engineering of the NASU, 47, Lenin Ave., 61103 Kharkiv, Ukraine

Rare-gas clusters, characterized by a relatively simple character of the

atomic interaction forces, are convenient model objects for testing various theoretical scenarios that describe mechanisms and velocities of formation of various physical properties in macrosystems. Rare-gas clusters also can serve as a model system for the metallic clusters, which are important from the viewpoint of their application. A large amount of papers are dedicated to the study of the structure of pure rare gases. At the same time, multicomponent clusters are much less studied so far. Here we study the structure and nucleation of clusters formed in an adiabatically expanding gas mixture Ar-Kr by electron diffraction. We found that small admixtures of Kr (1000 and 5000 ppm) cause an essential increase in Ar cluster size. This effect is due to the substitution of the heterogeneous clusterization for the homogeneous one. In this case, core aggregations are composed mainly of Kr atoms. This result correlates well with the data of optical measurements. It is also shown that at great concentrations of Kr (200000 ppm) only Kr clusters are formed. Argon is a carrying gas and favors temperature lowering in the Kr aggregations. We demonstrate that in large crystalline clusters (10ˆ4-10ˆ5 atoms per cluster) an hcp structure is realized. We discuss possible processes responsible for the formation of the hcp structure.