TT 8: Superconductivity - Poster Session

Time: Monday 14:00–17:45 Location: Poster A

TT 8.1 Mon 14:00 Poster A

Analysis and Optimization of Oxide Buffer Layers Related to YBCO Films Deposited by CSD and MOCVD on Biaxially Textured NiW Substrates — •Elmiloudi Elmechaouri, Burckhard Mönter, and Martin Hoffmann — Bergische Universität Wuppertal Gaußstraße 20, 42119 Wuppertal

The studies based on epitaxial buffer layers of CeO_2 and Yttria-stabilised ZrO_2 (YSZ) having been deposited on biaxially textured nickel substrates using thermal reactive evaporation and rf sputtering in continuous deposition processes in reel-to-reel systems. Starting from the well known architecture of CeO_2/ YSZ/ CeO_2 the thickness of the different buffer layers was varied. Misorientation, porosity and roughness was analyzed and optimized for YBCO deposition by MOCVD und CSD. The grain morphology and the behavior of the grain boundary networks in YBCO coated conductors have been shown to depend on both the YBCO deposition method and the buffers layer. The possibility of using only one and two buffers layer and conductive layers of perovskite type was studied. X-ray-diffraction, SEM and TEM have been used to investigate the microstructure of both the buffer layers and the YBCO films. Optimal growth conditions of YBCO for the different buffer layers have been determined. YBCO films were deposited by CSD, MOCVD and for comparison by high pressure dc sputtering, resulting on CeO_2/YSZ/CeO_2 buffered substrates Jc values higher than 2 MA/cm^2. The resulting superconducting properties were measured by inductive characterization and by Hall probe measurements of the Magnetic field due to induced magnetization currents.

TT 8.2 Mon 14:00 Poster A

TEM analysis of biaxially textured $La_2Zr_2O_7$ thin films by the Moiré technique — •Leopoldo Molina[1], Kerstin Knoth[2], Bernhard Holzapfel[2], and Oliver Eibl[1] — [1]Institute of Applied Physics, University of Tübingen, Auf der Morgenstelle 10, D-72076, Tübingen, Germany — [2]IFW Dresden, P.O.Box 270116, D-01171 Dresden, Germany

Chemically deposited $La_2Zr_2O_7$(LZO) buffer layers on biaxially textured nickel tungsten substrates for $YBa_2Cu_3O_{7-\delta}$(YBCO) coated conductor technology have been investigated by transmission electron microscopy (TEM). The biaxially textured LZO thin films were 80 nm thick and were annealed at T = 900°C. The samples were then prepared in plan-view for TEM investigations. The Ni grain size is about 40 μm, whereas the grain size of the LZO films is about 100 nm. The Moiré fringe contrast magnifies the misorientation of the LZO grains with respect to the underlying Ni grain by about a factor of 10. Imaging of small rotations ($\leq 3°$) of the LZO grains with respect to the underlying nickel tungsten grains was possible. Thus, the large misfit of 7.6 % between the LZO film and the nickel tungsten substrate might be additionally compensated by the tilting of the small LZO grains rather than by only introducing misfit dislocations at the substrate-film interface.

TT 8.3 Mon 14:00 Poster A

Ru moment in the magnetically ordered superconductor $RuSr_2GdCu_2O_8$ — •Thomas P. Papageorgiou[1], Eugenio Casini[2], Yuri Skourski[1], Thomas Herrmannsdörfer[1], Jens Freudenberger[3], Hans F. Braun[2], and Jochen Wosnitza[1] — [1]Hochfeld-Magnetlabor Dresden (HLD), Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany — [2]Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany — [3]IFW Dresden, Institute for Metallic Materials, D-01171 Dresden, Germany

Magnetization measurements of the superconducting ($T_c \approx 47$ K) and magnetically ordered ($T_M^{Ru} \approx 130$ K) $RuSr_2GdCu_2O_8$ (Ru1212) have been performed in pulsed magnetic fields up to 47 T. The average Ru-moment, determined by using $NbSr_2GdCu_2O_8$ as reference, is 1.8 μ_B suggesting that the investigated sample is in a mixed valence state containing 87% Ru^{5+} (2 μ_B) and 13% Ru^{4+} (0.9 μ_B). This ratio is consistent with an underdoped nature of the superconducting state with a hole concentration in the CuO_2 plane of $p \approx 0.065$. It is suggested that the magnetic structure of Ru1212 consists of a main antiferromagnetic phase formed by Ru^{5+}ions interrupted by ferromagnetic stripes, where double exchange between Ru^{5+} and Ru^{4+} ions takes place. Different Ru^{5+}/Ru^{4+} ratios, due to different preparation conditions, could explain some of the diverse superconducting and magnetic properties reported in the literature for Ru1212.

TT 8.4 Mon 14:00 Poster A

High-Resolution Specific-Heat data of $YBa_2Cu_3O_x$ up to 400 K — •Christoph Meingast[1], Akira Inaba[2], Thomas Wolf[1], Volker Pankoke[1], Rolf Heid[1], and Klaus-Peter Bohnen[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — [2]Research Center for Molecular Thermodynamics, Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan

Very accurate (0.1 percent) adiabatic specific heat measurements up to 400 K have been made on $YBa_2Cu_3O_x$ samples with oxygen contents x = 6.7, 6.9 and 7.0. The oxygen deficient samples clearly show an anomaly due to the oxygen ordering above room temperature. In order to analyze this oxygen-ordering contribution, as well as the electronic contribution, in detail, the phonon contribution, obtained by first-principles electronic structure calculations, was subtracted from the data. This subtraction works quite well, which demonstrates the quality of both the measured and calculated heat capacities.

TT 8.5 Mon 14:00 Poster A

Anomalous magnetic field dependence of the superconducting condensation energy in $YBa_2Cu_3O_7$ single crystals — •P. Popovich[1,2], C. Meingast[1], S. Tajima[3], and T. Masui[3] — [1]Forschungszentrum Karlsruhe, Institute for Solid-State Physics, 76021 Karlsruhe, Germany — [2]Fakultät für Physik, Universität Karlsruhe, Germany — [3]ISTEC, Tokyo, Japan

The anisotropic magnetostriction and thermal expansion of untwinned $YBa_2Cu_3O_7$ single crystals have been studied using capacitance dilatometry for $H||c$ along all crystallographic axes. The thermodynamical analysis is possible due to the high crystal quality. The magnetostriction coefficient $\lambda_i = \frac{1}{L_i}\frac{dL_i}{dH}$ (i=a,b,c) is reversible above 55 K, providing important information about the pressure dependencies of the thermodynamical critical field $H_c(T)$.

The magnetic field dependence of the zero-temperature superconducting condensation energy is obtained by using the fact that the length (volume) difference between normal and superconducting states, L_n-L_s, provides a direct measure of the uniaxial pressure (hydrostatic pressure) dependence of the superconducting condensation energy. In conventional BCS superconductors, the superconducting condensation energy, as well as the magnitude of L_n-L_s, decreases monotonically with increasing field due to the increasing density of normal-state vortex cores. We find practically no field dependence of L_n-L_s as T approaches zero, which implies that the superconducting pairing energy is nearly field-independent in magnetic field up to 10 T.

TT 8.6 Mon 14:00 Poster A

Thermal Conductivity of underdoped $YBa_2Cu_3O_y$ — •Robert Schneider[1], Anja Waske[1], Christian Hess[1], Bernd Büchner[1], Vladimir Hinkov[2], and Chengtian Lin[2] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01171 Dresden, Germany — [2]Max Planck Institute for Solid State Research, Heisenbergstrae 1, D-70569 Stuttgart, Germany

We present experimental results on the thermal conductivity κ of an untwinned, underdoped $YBa_2Cu_3O_y$ monocrystal along the 'a direction' with a critical temperature of $T_c = 61$ K. We observe a peak at low temperatures as it has been previously found for the optimally doped material, for which it is known that the peak originates from heat transport by electronic quasiparticles. However, unlike for this latter case we do not observe a sharp onset of the peak at T_c but find a continuous increase already below $T \approx 150$ K. This increase becomes steeper at T_c and κ eventually peaks around 30 K. A magnetic field perpendicular to the CuO_2 planes significantly suppresses κ in the superconducting phase.

TT 8.7 Mon 14:00 Poster A

Surface studies of underdoped $YBa_2Cu_3O_{6.6}$ by means of Scanning Tunneling Microscopy — •Grzegorz Urbanik[1,2], Torben Hänke[1], Christian Hess[1], Bernd Büchner[1], Antoni Ciszewski[2], Vladimir Hinkov[3], and Chengtian Lin[3] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01171

Dresden, Germany — [2]Institute of Experimental Physics, University of Wroclaw, Poland — [3]Max Planck Institute for Solid State Research, Heisenbergstrae 1, D-70569 Stuttgart, Germany

According to the data in the literature, low temperature (< 40 K) cleaving of $YBa_2Cu_3O_{7-\delta}$-single crystals under UHV conditions (in order to get high quality surfaces), leads mainly to either BaO or CuO sheets as the topmost layer. We performed scanning tunneling microscopy and spectroscopy on high quality underdoped $YBa_2Cu_3O_{6.6}$ crystals. We present topographic results and a detailed statistical analysis of the step heights on a micrometer scale. Our data show that the cleaving of this material below 40K is much more complicated than anticipated. We find that the material primarily cleaves in multiples of one unit cell. Fractional step heights are also found, but only in few cases ($\sim 5\%$). The topmost layers often exhibit a high corrugation ($\sim$ 3 Å) which indicates that cleaving takes place at either the CuO chain layer or the Y-layer involving a non-uniform distribution of the layer atoms on the two cleaving planes. Furthermore, scanning tunneling spectroscopy reveals that terraces with a height difference smaller than one unit cell differ significantly in their tunneling conductance.

TT 8.8 Mon 14:00 Poster A

The bulge in the basal plane of cuprate superconductors - evidence for $3a$ singlet hole pair formation — •Jürgen Röhler — Universität zu Köln, 50937 Köln, Germany

In the cuprate superconductors the variaton of the basal lattice parameters upon doping is expected to follow the ubiquitous 1-log$m$ behavior of interatomic distances in systems with varying covalency – a behavior discovered by L. Pauling within his theory of resonant valence bonds. m is the degree of covalency. Detailed crystallographic work from the hole doped cuprates, however, finds the interatomic distances in the CuO_2 planes (plotted as a^2 or ab) concave away from the doping axis, not convex toward it. The resulting bulge in the basal plane area is maximum at optimum doping $n_{opt} \simeq 0.16$, and collapses within the weakly overdoped regime around $n \simeq 0.22$. We connect the bulge with a doping dependent repulsive interaction arising from the higher stability of the resonant (ZR) singlet hole states relative to that of single nn singlet hole states. Thus ZR singlet hole states tend to suppress double occupations of their oxygen cages, hence suppressing the formation of nonresonant $1a$ (nn) singlet hole pairs. Instead $3a$ singlet hole pairs comprising 4 oxygen cages are favored. Within the concept of a superconducting quantum liquid of valence bonds resonating around among different pairings of atoms the constraint to $3a$ hole pair formation creates a strongly textured liquid with nodes along (π, π) in reciprocal space. We show that in this textured liquid $3a$ singlet hole pairs may propagate dissipationless along the Cu–O directions in the background of antiferromagnetically correlated Cu spins.

TT 8.9 Mon 14:00 Poster A

X-ray absorption spectroscopy study of hole doping on Pb-Bi2201 single crystals — •Ahmad Kamal Ariffin, Beate Müller, Rüdiger Mitdank, Lenart Dudy, Helmut Dwelk, Alica Krapf, Christoph Janowitz, and Recardo Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, D-12489 Berlin

X-ray absorption spectroscopy is a reliable technique to evaluate the hole content n_H in polycrystalline oxide-based high temperature superconductors. For single crystals, the same method can be used by taking into consideration the dependency of the absorption on orientation of the polarization vector in the CuO_2-plane. The polarization i.e. angular dependence of the main and satellite peak at the Cu-L_3 edge of $Bi_{2-y}Pb_ySr_{2-x}La_xCuO_{6+\delta}$ (Pb-Bi2201) single crystals was studied by XAS over a wide doping range. The optimum and the underdoped samples show maxima and minima corresponding to the high symmetry lines of the Brillouin zone. The hole content n_H can be determined as angular average. However, in the hole overdoped sample, the peak ratio does not reflect n_H directly. This will be discussed in the context of data on polycrystalline materials [1].

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

TT 8.10 Mon 14:00 Poster A

Quasiparticle approach to electronic Raman scattering in overdoped cuprates — •Wolfgang Prestel[1], Bernhard Muschler[1], Yoichi Ando[2], Shimpei Ono[2], and Rudi Hackl[1] — [1]Walther-Meissner-Institut, Garching — [2]CRIEPI, Tokyo, Japan

High-T_c superconductors can be described as normal, though strongly correlated, metals in the overdoped regime. This implies that the conduction electrons in these materials can be viewed as independent quasiparticles with defined momenta and a certain lifetime. Here we explore the capability of this concept to explain the electronic Raman response in overdoped cuprates. The Raman response can be calculated in linear response theory using a generalized Kubo formula. Owing to the **k**-dependence of the Raman vertices, selected by the polarizations of the incoming and outgoing photons, different parts of the Brillouin zone can be projected out independently. In order to evaluate the Kubo formula one additionally needs the spectral function of the quasiparticles. In our model we assume a bandstructure and quasiparticle lifetimes as derived from ARPES experiments in order to calculate the Raman response for the B_{1g} and B_{2g} symmetries. Comparing model data and Raman spectra of $La_{2-x}Sr_xCO_4$ and $Bi_2Sr_2CaCu_2O_{8+\delta}$, we find remarkable agreement concerning symmetry and temperature dependences in both material systems. This suggests that the quasiparticle approach is a reasonable starting point to explain carrier dynamics in overdoped cuprates.

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TT 8.11 Mon 14:00 Poster A

Elektromagnetischer Response und Raman-Streuung in unkonventionellen Supraleitern — •Ludwig Klam und Dietrich Einzel — Walther-Meißner-Institut, 85748 Garching

Wir untersuchen sowohl den eichinvarianten elektromagnetischen als auch den elektronischen Raman-Response für unkonventionelle Supraleiter mit d-Wellen- (Spin-Singulett-) Paarkorrelationen. Im stoßlosen Bereich werden frühere Resultate auf beliebige quasiklassische Wellenzahlen erweitert, mit der einzigen Einschränkung, dass das Konzept der Teilchen-Loch-Symmetrie seinen Sinn behält. Die Resultate schließen notwendige Verallgemeinerungen der Lindhardfunktion, der dielektrischen Funktion, der dynamischen Leitfähigkeit und der Raman-Responsefunktion des Supraleiters auf beliebige Wellenzahlen ein. Die Theorie behält die wichtige Eigenschaft der Eichinvarianz und garantiert somit die Transversalität der Suprastroms im stationären Limes. Auch das Wechselspiel zwischen der langreichweitigen Coulomb-Wechselwirkung und der Bogoliubov-Anderson- (Eich-) Mode des Supraleiters behält seine qualitative Bedeutung bei beliebigen Wellenzahlen.

TT 8.12 Mon 14:00 Poster A

Response und Relaxation in unkonventionellen Supraleitern — •Ludwig Klam und Dietrich Einzel — Walther-Meißner-Institut, 85748 Garching

Wir untersuchen den stoßlimitierten elektronischen Raman-Response und die Ultraschallabsorption für unkonventionelle Supraleiter mit d-Wellen- (Spin-Singulett-) Paarkorrelationen bei tiefen Temperaturen. Die hier dominierenden elastischen Stöße werden im Rahmen einer T-Matrix-Näherung betrachtet, die sich auf reine s-Wellenstreuung beschränkt. Im langwelligen Limes ergibt sich eine Zweiflüssigkeits- beschreibung, bei der die Stöße ausschließlich die (Relaxations-) Dynamik des (Bogoliubov-) Quasiteilchengases dominieren und die sich je nach Transportprozess (Raman, Impulsstrom) durch unterschiedliche Quasiteilchen-Relaxationzeiten beschreiben lassen. Bei einer Anwendung auf quasi-zweidimensionale Systeme wie die Kuprat-Supraleiter zeigt sich, dass der mit der Raman-Streuintensität verknüpfte Transportparameter für B1g- und B2g-Photonpolarisation sehr eng mit entsprechenden Komponenten des Viskositätstensors korreliert ist, welche die Ultraschallabsorption dominieren. Bei tiefen Temperaturen sind analytische Lösungen der Transportgleichungen möglich, die sowohl den Grenzfall schwacher (Born-Limes) und starker (unitärer Limes) Streuung einschließen.

TT 8.13 Mon 14:00 Poster A

Time-dependent Gutzwiller theory of pair fluctuations in the attractive Hubbard model — •Falk Günther and Götz Seibold — BTU Cottbus, PO BOX 101344, 03013 Cottbus

The time-dependent Gutzwiller approximation (TDGA) is extended towards the inclusion of pair correlations.

The expansion of the charge-rotational invariant Gutzwiller energy functional around the saddle point allows the computation of dynamic correlation functions using the random-phase approximation (RPA). Unlike the BCS approach the interaction kernel in the TDGA mediates intersite pair scattering and also contains processes where pairs of electrons are created and annihilated on distant sites. It turns out that the TDGA can capture the crossover from weak to strong coupling in good agreement with Quantum Monte Carlo calculations in contrast to the BCS approximation.

As a further application we evaluate the excitations of the superconducting ground state. From the calculation of the instabilities in the particle-hole channel we construct the phase diagram for superconducting and charge order in two dimensional lattices.

TT 8.14 Mon 14:00 Poster A

Superconducting critical temperature and Fermi surface of hydrated cobalt compounds — •Jose Roberto Iglesias, Christopher Thomas, and Acirete Simoes — Instituto de Fisica, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

We study the properties of some hydrated superconducting cobalt compounds of the type of $Na_xCoO_2{\cdot}y(H_2O)$ in the superconducting phase. These compounds consist of CoO_2 layers separated by Na ions and water molecules, resulting in a Co triangular lattice. The theoretical approach here considered is an extended Hubbard model and we obtain the normal and anomalous Green functions of the system limit using mean field approximation for the inter-atomic interactions and Hubbard-I approximation for the intra-atomic ones. We consider the paramagnetic case and we analyze the coupling between electrons with different symmetries, so obtaining the singlet and triplet superconducting order parameters. The superconducting transition temperatures, T_c, are obtained in both cases. The doping dependence of T_c obtained for the triplet case is in a qualitative agreement with experimental results. Finally the Fermi surface is also calculated and compared with ARPES results.

TT 8.15 Mon 14:00 Poster A

Influence of Andreev bound states on the screening current and the magnetic field in a d-wave superconductor. — •Alexander Markowsky, Thomas Dahm, and Nils Schopohl — Universität Tübingen, Lehrstuhl für Theoretische Festkörperphysik, Auf der Morgenstelle 14, 72076 Tübingen

In the present work, we investigate how the Meissner-Ochsenfeld effect is modified near a surface of a d-wave superconductor. In a d-wave superconductor, surface Andreev bound states form within the energy gap depending on the orientation of the d-wave pairing condensate with respect to the boundary. By means of the Eilenberger theory, we study the influence of an external magnetic field on the Andreev bound states and the screening currents. In particular, the current changes its direction at the surface and a splitting of the bound state can be seen. We study the temperature dependence and orientational dependence of this effect.

TT 8.16 Mon 14:00 Poster A

Superconductivity in a semiconductor - interband interaction — •Susanne Killiches[1] and Khandker Quader[2] — [1]Institut fuer Physik, Universitaet Rostock — [2]Department of Physics, Kent State University, OH USA

Recent experiments [Steiner,Kapitulnik, Physica C, Volume 422, Issue 1-2 p.16-26, 05/2005] have demonstrated that superconductivity can grow out of a non-metallic insulating phase. To explain that phenomena we study a simplified two band model. The idea for explanation is to introduce an attraction in the valence and conduction band of either intra- or inter band nature. The transition to a superconducting phase should occur if the gain in pairing energy by forming an electron-electron pair is greater than its cost [Jrome, Rice, Kohn, Phys. Rev. 158, 462475, 1967]. Using the Matsubara Greens function method, a gap equation for a semiconductor model in 2D is derived, allowing only for inter-band interaction [Nozieres, Pistolesi, European Physical Journal B, Volume 10, #4, 08/1999]. The characteristic gap equation is solved for zero and finite temperature numerically and the behaviour of the transition temperature depending on the excitation gap and order parameter is shown. We find superconductivity, if the coupling exceeds a certain threshold and obtain a successful model to describe the superconductor-insulator transition.

TT 8.17 Mon 14:00 Poster A

Novel superconducting graphite compound: CaC_6 - synthesis and conduction electron spin resonance study — •Ferenc Murányi, Grzegorz Urbanik, Vladislav Kataev, and Bernd Büchner — Leibniz Institute for Solid State and Materials Research Dresden, 01171 Dresden, PO BOX 270116, Germany

The superconductivity in calcium intercalated graphite (CaC_6) with transition temperature (T_c) of 11.5 K was discovered in 2005. The new material attracts great attention because of its high T_c among intercalated graphite compounds, highly anisotropic critical field (H_{c2}) and layered structure like MgB_2 or high temperature superconductors. Bulk intercalated samples were prepared during 10 days' heat treatment of graphite pieces at 350 °C in Li rich Ca/Li alloy. Conduction Electron Spin Resonance (CESR) lines were observed in the temperature range from 4 K to 300 K at 9.5 GHz, in two magnetic field orientations, H‖ c and H‖ ab. The lineshape can be described as a Dysonian line which is characteristic of thick slabs of metals. The g factor ($g_c = g_{ab} = 1.9984$ +/- 0.0005), the linewidth ($w_c = w_{ab} = 4$ +/- 0.5 G) and the intensity are typical for the metallic state, in both magnetic field orientations.

TT 8.18 Mon 14:00 Poster A

Angular dependant critical field and critical currents of epitaxial Holmium Nickel Borocarbide Thin Films — •Tim Niemeier, Ruben Hühne, Günter Behr, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, 01171 Dresden

Epitaxial thin films of $HoNi_2B_2C$ and related superconducting rare earth borocarbide compounds act as a suitable basis for numerous investigations on structural and superconductive properties such as T_c, H_{c2} and J_c.

A new batch of $HoNi_2B_2C$ thin films was grown on ceramic single crystal magnesium oxide substrates under ultra-high vacuum conditions using pulsed laser deposition. A detailed view on the deposition parameters and the physical film properties is presented and angular H_{c2}- and J_c-measurements are shown.

TT 8.19 Mon 14:00 Poster A

Determination of the band structure of $LuNi_2B_2C$ — •Beate Bergk[1,2], Marek Bartkowiak[1], Oleg Ignatchik[1], Manfred Jäckel[2], Joachim Wosnitza[3], Helge Rosner[3], Vivien Petzold[3], and Paul Canfield[4] — [1]Hochfeld-Magnetlabor Dresden, Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany — [2]Institut für Festkörperphysik, TU-Dresden, D-01062 Dresden, Germany — [3]MPI für chemische Physik fester Stoffe, D-01187 Dresden, Germany — [4]Condensed Matter Physics, Ames Laboratory, Ames, Iowa 50011,

We present de Haas-van Alphen (dHvA) investigations on the non-magnetic borocarbide superconductor $LuNi_2B_2C$ which have been performed by use of the torque method in high magnetic fields up to 32 T and at low temperatures down to 50 mK. The complex band structure is extracted from the quantum oscillations in the normal state. In comparison with full-potential-local-orbital calculations of the band structure we are able to assign the observed dHvA frequencies to the different bands. Temperature dependent dHvA investigations allowed the extraction of the effective band masses for the several Fermi-surface sheets. We observe an enhancement of the effective masses compared to the theoretical calculations which is due to electron-phonon interaction. Finally, we are able to examine the angular dependence of the electron-phonon coupling for the different Fermi-surface sheets.

TT 8.20 Mon 14:00 Poster A

Superconductivity and electron-phonon coupling in doped MgB_2 and related compounds — •Vivien Petzold[1], Klaus Koepernik[1,2], and Helge Rosner[1] — [1]MPI CPfS Dresden, Germany — [2]IFW Dresden, Germany

Recently, substitutions on the Mg site in MgB_2, e.g., $Mg_{1-x}Sc_xB_2$, $Mg_{1-x}(AlLi)_xB_2$ were investigated intensively. For achievable doping levels, $Mg_{1-x}Sc_xB_2$ shows only very small structural changes but clear changes in the electronic structure, whereas AlLi doping affects the lattice parameters but has almost no influence on the electronic structure. Our theoretical approach comprises different approximations in the framework of band structure calculations: the rigid band and virtual crystal method as well as supercell calculations and coherent potential approximation. We show that the latter two lead to consistent results with respect to lattice expansion and electronic properties. We show that lattice effects are of minor importance. Concluding that the B 2p σ states remain the most relevant subsystem with regard to superconductivity, we calculated the electron phonon coupling constant λ and the critical temperature T_c. In contrast, for ZrB_2 as a typical representative of transition metal diborides TB_2 we find the sp^2(B)-d(T) hybridization to be crucial. Comparing calculated and measured angle dependent dHvA-data we show that: (i) LDA provides an excellent description of the electronic structure of TB_2. (ii) The electron phonon coupling is too small to expect superconductivity above a few mK for the stoichiometric compounds.

The Emmy-Noether program is acknowledged for financial support.

TT 8.21 Mon 14:00 Poster A

Nonlinear Temperature Dependence of the Upper Critical Magnetic Field for Magnesium Diboride — •Thomas Koch[3], Thomas Schimmel[3,4], Maria Palistrand[2], Vladimir Zdravkov[1], and Anatolie Sidorenko[1] — [1]Institute of Electronic Engineering and Industrial Technologies, ASM, MD-2028 Kishinev, Moldova — [2]Institute of Applied Physics, ASM, MD-2028 Kishinev, Moldova — [3]Institute of Nanotechnology, Forschungszentrum Karlsruhe D-76021 Karlsruhe, Germany — [4]Institute of Applied Physics, University of Karlsruhe D-76128 Karlsruhe, Germany

The temperature dependence of the upper critical magnetic field, Hc_2(T), for MgB_2 films was investigated. As one result a nonlinear behavior of Hc_2(T) shown in the positive curvature in the H(T) plots is found to be an intrinsic property of the novel superconducting material. The experimental results are compared with the calculations made within the theoretical model of inter-band interaction for multi-band superconductors.[1]

Reference 1. M. E. Palistrant, Upper Critical Field Hc_2 in Two-Band Superconductors, Mold.Journ. Phys.Sci 3 (2004) 61

TT 8.22 Mon 14:00 Poster A

Enhanced superconductivity of Pb nanograins on a biological substrate — •T. Herrmannsdörfer[1], O. Ignatchik[1], T. P. Papageorgiou[1], F. Pobell[1], C. Walter[1], J. Wosnitza[1], C. Hennig[2], M. Merroun[2], K. Pollmann[2], J. Raff[2], S. Selenska-Pobell[2], and J. von Borany[3] — [1]Hochfeld-Magnetlabor Dresden (HLD), — [2]Institut für Radiochemie, — [3]Institut für Ionenstrahlphysik und Materialforschung, Forschungszentrum Dresden-Rossendorf, D-01314 Dresden, Germany

Nanogranular materials attract more and more attention due to their exciting physical properties as well as their key role in future technologies. Compared to their bulk counterparts, nanogranular materials can reveal strongly altered properties. As an example, we have demonstrated that the Stoner enhancement factor of the d conduction-electron susceptibility of Pd and Pt nanoclusters is clearly reduced compared to the one of the bulk transition metals. Now we have focused on superconducting properties of lead particles of a well defined single grain size of 19 nm. As for Pd and Pt, these metal nanoclusters have been deposited on a biological template, a purified self-assembling paracrystalline surface layer (S-layer) of Bacillus sphaericus JG-A12 which is composed of identical protein monomers. After a determination of their grain size using x-ray powder diffraction, we have investigated their superconducting B-T phase diagram by means of SQUID magnetometry. The Pb clusters reveal a superconducting critical field of the size of several Tesla which is strongly enhanced compared to the corresponding critical magnetic field of 0.09 T for bulk Pb.

TT 8.23 Mon 14:00 Poster A

Strong anisotropic superconducting behavior in the dichalcogenide $SnSe_2$ intercalated with cobaltocene — •Robert Miller[1], Sandra Altmannshofer[1], Ernst-Wilhelm Scheidt[1], Rudolf Herrmann[1], Franz Mayr[2], Dietrich Einzel[3], and Wolfgang Scherer[1] — [1]CPM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [2]EP V – EKM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — [3]Walther-Meissner-Institut für Tieftemperaturforschung, 85748 Garching, Germany

We present a detailed study of the layered dichalcogenide $SnSe_2$ intercalated with the organometallic donor molecule cobaltocene, which exhibits a superconducting transition at $T_c = 6\,K$. The extremely anisotropic superconducting behavior is reflected by an in-plane and off-plane resistivity, which deviate from each other by a factor of 200 just before superconductivity sets in. Furthermore, this strong anisotropy leads to two different superconducting transition temperatures, one goes in line with the in-plane and the other with the off-plane superconductivity . In addition, specific heat studies clearly characterize the intercalated $SnSe_2$ as a bulk superconductor with these two different T_c's.

TT 8.24 Mon 14:00 Poster A

Superconducting transport properties of Co-Pt/Nb/Co-Pt triple layers with perpendicular magnetic anisotropy — •Ajay Singh[1], Christoph Sürgers[1,2], and Hilbert v. Löhneysen[1,2,3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

In a superconducting spin switch the transition temperature T_c of a superconductor (S) sandwiched between two ferromagnets (F) depends on the relative orientation of the F layer magnetizations. We report on the superconducting transport properties of FSF triple layers, where F is a Co-Pt multilayer with perpendicular magnetic anisotropy and S is Nb. T_c is lower for the antiparallel (AP) compared to the parallel (P) state. This is explained by the enhanced reflection of spin-polarized charge carriers into the S layer for the AP state. T_c is independent of the magnetization orientation if an insulating barrier is introduced between F and S at each of the two interfaces. We also provide additional data in order to prove that the T_c difference is likely to be related to the proximity effect and not due to residual magnetic stray fields of the F layers.

TT 8.25 Mon 14:00 Poster A

Electronic Transport in Superconductor-Ferromagnet-Heterostructures — •Dagmar Rall[1], Jakob Brauer[1], Detlef Beckmann[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik — [3]Physikalisches Institut, Universität Karlsruhe

Electronic transport in nanoscale superconductor-ferromagnet (SF) contacts at very low temperature is studied in order to identify nonlocal Andreev bound states. The samples consist of two parallel ferromagnetic film strips between superconducting leads. The strips are magnetized to exhibit a magnetic field which discourages direct Andreev reflection at the respective SF - interfaces. However, if the magnatization is antiparallel and the distances sufficiently small, the setup allows for a non-local reflection of the electrons in one strip to holes in the other strips and vice versa. This way, a bound state may form, giving rise to a Josephson current across the junction.

TT 8.26 Mon 14:00 Poster A

Nonlocal transport in superconductor/normal metal heterostructures — •Jakob Brauer[1], Detlef Beckmann[1], and Hilbert v. Löhneysen[2,3] — [1]Forschungszentrum Karlsruhe, INT — [2]Forschungszentrum Karlsruhe, IFP — [3]Physikalisches Institut, Universität Karlsruhe

Injection of electrons from a normal metal into a superconductor with electron energies below the superconducting gap Δ (measured from the Fermi energy) is only possible by means of Andreev reflection, where an incident electron gets reflected as a hole with opposite spin at the NS interface.

If multiple interfaces are present nonlocal (or crossed) Andreev reflection (CAR) and electron cotunneling (EC) can occur. For an electron injected at an interface A, CAR leads to an emitted hole at a different interface B. On the other hand electron cotunneling yields an emitted electron at B.

To observe these effects we examine samples created by e-beam lithography and shadow evaporation technique. These consist of multiple NS (copper/aluminium) tunnel junctions with spatial seperation of injector and detector contacts of around 150 nm. We present experimental data on local and nonlocal electronic transport measurements.

TT 8.27 Mon 14:00 Poster A

Enhanced stray field compensation in Nb/FePt bilayers — •Silvia Haindl, Martin Weisheit, Sebastian Fähler, Ludwig Schultz, and Bernhard Holzapfel — Institute for Metallic Materials, IFW, Postfach 27 01 16, 01171 Dresden, Germany

Epitaxial Nb/FePt thin film bilayers were prepared by pulsed laser deposition under UHV conditions. FePt is a highly coercive ferromagnet and therefore shows no switching in the field range of the superconducting phase at low temperatures. With the magnetic moments of the FePt grains aligned perpendicular to the film plane, the stray field between the individual grains acts already on the superconductor in the field-free case. Under application of a magnetic field, the stray field can be compensated, accompanied by an observable increase of the transition temperature. Using hard magnetic materials an enhanced effect of stray field compensation was observed when 0.25 T of applied field raises T_C about 0.5 K. The B(T)-phase diagram of the heterostructures was investigated, and its behavior was controlled by varying the FePt layer thickness.

TT 8.28 Mon 14:00 Poster A

Odd Triplet Superconductivity in Superconductor/Ferromagnet Structure with a Spiral Magnetic Structure — •Alexandra Anishchanka — Querenburger Hoehe, 97, Bochum,

44801, Deutschland

We analyze a superconductor-ferromagnet (S/F) system with a spiral magnetic structure in the ferromagnet F for a weak and strong exchange field. The long-range triplet component (LRTC) penetrating into the ferromagnet over a long distance is calculated for both cases. In the dirty limit (or weak ferromagnetism) we study the LRTC for conical ferromagnets. Its spatial dependence undergoes a qualitative change as a function of the cone angle ϑ. At small angles ϑ the LRTC decays in the ferromagnet exponentially in a monotonic way. If the angle ϑ exceeds a certain value, the exponential decay of the LRTC is accompanied by oscillations with a period that depends on ϑ. This oscillatory behavior leads to a similar dependence of the Josephson critical current in SFS junctions on the thickness of the F layer. In the case of a strong ferromagnet the LRTC decays over the length which is determined by the wave vector of the magnetic spiral and by the exchange field.

TT 8.29 Mon 14:00 Poster A

A quest for the optimal design of π-coupled Josephson junctions — •Dirk Sprungmann, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum

In recent years investigations of so called π-coupled Josephson junctions became very popular. In an ordinary currentless SIS or SNS junction the pair wave functions on both sides of the tunnel barrier have a phase shift of zero. By introducing a thin ferromagnetic layer with a certain thickness d_{Fc} between the two superconductors it is possible, to obtain a phase shift of π between the two superconducting layers in the ground state. This causes a sign change of the critical Josephson current I_c and leads to a crossover within the $I_c(d_F)$-curve. To establish a solid basis to analyse these electronic components systematically, we first tried to find an optimal design of the junction. In order to avoid any breaking of the vacuum and to keep all the interfaces in the junction clean, we checked two in-situ preparation procedures, in which only shadow masks and dry-etching processes are applied. We will compare these in-situ designs with established concepts using e-beam lithography. We present abortive and successfull sample designs of these exciting electronic devices and describe advantages disadvantages as well as crucial pitfalls. We acknowledge financial support through SFB 491.

TT 8.30 Mon 14:00 Poster A

0 and π phase Josephson coupling through an insulating barrier with magnetic impurities — •O. Vávra[1,2,3], Š. Gaži[2], I. Vávra[2], D. S. Golubović[1], J. Dérer[2], and V. V. Moshchalkov[1] — [1]Nanoscale Superconductivity and Magnetism Group, Laboratory for Solid State Physics and Magnetism, K. U. Leuven, Celestijnenlaan 200 D, B-3001 Leuven, Belgium — [2]Institute of Electrical Engineering, Slovak Academy of Sciences, Dúbravská cesta 9, SK-841 04 Bratislava, Slovak Republic — [3]Institut für experimentelle und angewandte Physik, Universität Regensburg, D-93025 Regensburg, Germany

We present the experimental evidence of the existence of the π state in the Josephson junction with magnetic impurities in the insulating barrier. We have studied temperature and field dependencies of the critical current I_C in the Nb-$Fe_{0.1}Si_{0.9}$-Nb Josephson junction with tunneling barrier formed by paramagnetic insulator. We demonstrate that in these junctions the co-existence of both the 0 and the π states within one tunnel junction takes place which leads to the appearance of a sharp cusp in the temperature dependence $I_C(T)$ similar to the $I_C(T)$ cusp found for the $0-\pi$ transition in metallic π junctions. This cusp is not related to the $0-\pi$ temperature induced transition itself, but is caused by the different temperature dependencies of the opposing 0 and π supercurrents through the barrier.

TT 8.31 Mon 14:00 Poster A

Josephson π-junctions and their application in superconducting flux qubits — •Georg Wild, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Superconducting flux qubits suffer from the need of a flux bias, which has to be extremely stable in time. This problem can be circumvented by inserting an additional π-phase shift element in the qubit ring, which formally replaces this flux bias. A phase shift of π between the phases of two superconductors (S) is provided by a Josephson junction (JJ), where the weak coupling is established by a thin ferromagnetic metal layer (F) of appropriate thickness. For applications in quantum circuits, where damping and decoherence has to be minimized, an insulating layer (I) is needed to increase the quality factor of the junction. For the realization of flux qubits with π-phase shift elements we have developed an in-situ self-aligned multilayer process to realize SIFS-JJ. Our junctions show RCSJ-like current-voltage characteristics and a Fraunhofer pattern like modulation of the critical current with magnetic field. The dependence of the I_cR_n-product on the ferromagnet thickness shows a crossover between the zero- and the π-state.
This work was supported by the DFG via SFB 631.

TT 8.32 Mon 14:00 Poster A

Investigation of dynamic effects in 0, π and 0-π SIFS Josephson junctions — •Judith Pfeiffer[1], Edward Goldobin[1], Martin Weides[2], Matthias Kemmler[1], Andreas Dewes[1], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Universität Tübingen, Experimentalphysik II, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Forschungszentrum Jülich GmbH, Institut für Festkörperforschung, 52425 Jülich

We present experimental and numerical studies of high quality underdamped SIFS Josephson junctions (JJ) fabricated as $Nb/Al_2O_3/Cu_{40}Ni_{60}/Nb$ heterostructures. Varying the thickness of the ferromagnetic barrier we can create 0, π and 0-π junctions. From measurements of the current voltage characteristic (*IVC*) and critical current I_c vs. magnetic field H we find record values for the critical current density j_c in the π-state. The $I_c(H)$ data for the 0-π JJ show a clear minimum at $H = 0$. Dynamical phenomena such as Fiske steps and zero field steps are visible on the *IVCs*. In the case of the 0-π junction we are able to detect a half-integer zero field step due to the dynamics of a semifluxon. The dissipation in all these JJs is not linear, but the linear part decreases exponentially with a decreasing temperature in the range between 4.2 and 2.1 K.

TT 8.33 Mon 14:00 Poster A

Spectroscopy of the fractional vortex eigenfrequency in a long Josephson 0-κ junction — •Kai Buckenmaier[1], Tobias Gaber[1], Inga Schittenhelm[1], Michael Siegel[2], Reinhold Kleiner[1], Dieter Koelle[1], and Edward Goldobin[1] — [1]Physikalisches Institut, Experimentalphysik II, Universitaet Tuebingen, Auf der Morgenstelle 14, D-72076 Tuebingen, Germany — [2]Universitaet Karlsruhe, Institut fuer Mikro– und Nanoelektronische Systeme, Hertzstr. 16, D-76187 Karlsruhe, Germany

In long Josephson junctions with a κ-phase discontinuity, created by two current injectors, a fractional Josephson vortex (FJV) is spontaneously formed at the interface between the 0- and κ-part. A FJV carrys an arbitrary fraction $\Phi/\Phi_0 = \kappa/2\pi$ of the magnetic flux quantum $\Phi_0 \approx 2.07 \times 10^{-15}$ Wb. In contrast to fluxons, FJVs are pinned at the discontinuity point, but in underdamped systems they are able to oscillate around their equilibrium point with characteristic eigenfrequencies. To experimentally determine the eigenfrequency we stimulated a FJV by irradiating our sample with microwaves. At resonance the junction switches to the resistive state. A measurement of the switching probability thus allows to determine the FJV eigenfrequency as a function of bias current and κ. We compare our results with the prediction of the pertubed sine-Gordon equation.

TT 8.34 Mon 14:00 Poster A

Thermal activation and phase diffusion in long submicron annular junctions — •Astria N. Price[1], Alexander Kemp[1], William D. Oliver[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, Erwin-Rommel-Str 1, 91058 Erlangen, Germany — [2]MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420, USA

We report measurements of the standard deviation of the switching current from the flux-free state in long annular Josephson junctions of differing submicron width, over the temperature range T ˜ 25 - 750 mK. A power law dependence is observed between 200 and 500 mK, while at lower temperatures the standard deviation saturates due to phase escape via quantum tunneling. As the temperature increases above T ˜ 500 mK the standard deviation decreases, which we interpret as an observation of phase diffusion in an extended Josephson system.

TT 8.35 Mon 14:00 Poster A

Superconductor-Constriction-Superconductor Josephson Junction in a Magnetic Field — •Andreas Gumann, Thomas Dahm, and Nils Schopohl — Universität Tübingen, Lehrstuhl für

Theoretische Festkörperphysik, Auf der Morgenstelle 14, 72076 Tübingen

Josephson junctions can be formed by a constriction of a superconducting material with lateral extension smaller than the coherence length. This kind of weak link, often referred to as ScS Josephson junction, is a useful starting point for theoretical considerations since only the properties of the superconductor and the geometry are relevant. We present self-consistent solutions of microscopic Eilenberger theory for a two-dimensional model of a ScS Josephson junction including magnetic fields, external ones as well as those generated by the screening and transport currents. We show results for the order parameter amplitude and phase, the currents, the magnetic vector potential and the local density of states. In particular, the effect of the external magnetic field on the Andreev bound states appearing in the junction is studied.

TT 8.36 Mon 14:00 Poster A

Development of metallic magnetic calorimeters for high-resolution X-ray spectroscopy — •Markus Linck, Andreas Burck, Loredana Gastaldo, Sebastian Kempf, Jan-Patrick Porst, Hannes Rotzinger, Sönke Schäfer, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg, Deutschland

X-ray detectors based on the concept of magnetic calorimetry are well suited for high-resolution spectroscopy. Metallic magnetic calorimeters (MMC) make use of a metallic paramagnetic temperature sensor, gold doped with few hundred ppm erbium, which is in tight thermal contact with a metallic absorber. The sensor is placed in a weak magnetic field, its magnetization is used to monitor the temperature. High-energy resolution can be obtainted by using a low-noise, high-bandwidth DC SQUID to measure the small change in magnetization upon the absorption of an X-ray.

In many applications it is important to have a detector that has a high stopping power for photons up to 10 keV and allows to measure with a high count rate. The design of the detector we present is based on a numerical calculation that gives the optimal values for sensor size, erbium concentration and applied magnetic field. The detector has a stopping power of about 98 % at 6 keV and the decay time has been improved by a better thermal link between the sensor and the thermal bath. The energy resolution we achieved is $\Delta E_{\mathrm{FWHM}} = 2.7\,\mathrm{eV}$ for X-ray energies up to 6.5 keV.

TT 8.37 Mon 14:00 Poster A

Properties of superconducting rhenium absorber for low temperature detectors — •J.-P. Porst[1], L. Gastaldo[1], S. Schäfer[1], M. Linck[1], A. Burck[1], S. Kempf[1], H. Rotzinger[1], A. Fleischmann[1], C. Enss[1], V. Zakosarenko[2], R. Stolz[2], and H.-G. Meyer[2] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, D-69120 Heidelberg, Germany — [2]Institute for Physical High Technology, Albert-Einstein-Str.9, D-07702 Jena, Germany

A still puzzling problem in the development of low temperature microcalorimeters for the measurement of ^{187}Re β-spectrum, is the understanding of the thermalization of energetic electrons in the superconducting rhenium absorber. We developed a metallic magnetic calorimeter (MMC) with a single crystal Re absorber and paramagnetic Au:Er temperature sensor. The energy released into the detector leads to a change of magnetization of the paramagnetic sensor located in a weak magnetic field. A meander shaped SQUID magnetometer is used to read out this change. This setup allows the study of several properties of the rhenium single crystal. The transition to the superconducting state is studied by measuring the magnetic flux expelled by the Re sample. The resistivity of Re above T_C can be estimated from the measurement of the spectral power density of the Johnson noise. Furthermore the quasiparticle lifetime can be investigated through the analysis of heat pulses caused by the absorption of X-rays. We present the data obtained in these experiments and discuss the physical quantities which can be derived from these.

TT 8.38 Mon 14:00 Poster A

Characterization of 3-dimensional superconductive thin film components for gravitational experiments in space. — •Stefan Hechler[1], Ronny Nawrodt[1], Sandor Nietzsche[1], Wolfgang Vodel[1], Hansjörg Dittus[2], Frank Löffler[3], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, Germany — [3]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Superconducting Quantum Interference Devices (SQUIDs) are used for high precise gravitational experiments. One of the most impressive experiments is the Satellite Test of the Equivalence Principle (STEP) of NASA/ESA. The STEP mission aims to prove a possible violation of Einstein's Equivalence Principle at an extreme level of accuracy of 1 part in 10^{18} in space.

In this contribution we present an automatically working measurement equipment to characterize 3-dimensional superconducting thin film components like i.e. pick-up coils and test masses for STEP. The characterization is done by measurements of the transition temperature between the normal and the superconducting state using a special built anti-cryostat. Above all the setup was designed for use in normal LHe transport Dewars. The sample chamber has a volume of 150 cm^3 and can be fully temperature controlled over a range from 4.2 K to 300 K with a resolution of better then 100 mK.

This work was supported by German DLR, contract 50 OY 0501.

TT 8.39 Mon 14:00 Poster A

Characterisation of new HTSC-gradiometers for spatial resolved measurments — •Alexander Steppke[1], Märit Djupmyr[2], Christoph Becker[1], Veit Grosse[1], Joachim Albrecht[2], Frank Schmidl[1], and Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Germany — [2]Max-Planck-Institut für Metallforschung, Stuttgart, Germany

We present a new layout for a high-T_c dc-SQUID gradiometer for spatially resolved measurements. The gradiometers were made on $SrTiO_3$ bicrystal substrates using pulsed laser deposition. The 150 nm $YBa_2Cu_3O_{7-x}$ films were structured using Argon ion beam etching.

An overview of the characteristic parameters of these HTSC-SQUIDs is given. We measured I_c, I_cR_n-product, transfer function depending on temperature and noise properties in environments shielded and unshielded from magnetic fields. Comparisons with numerical simulations of the electrical properties and magnetooptical images showing current densities in different fields are given.

Several applications are discussed with respect to the balance and effective area of the gradiometer structures.

TT 8.40 Mon 14:00 Poster A

Electromagnetic Exploration with SQUID magnetometers — •Andreas Chwala, Ronny Stolz, Nikolai Uhkansky, Frank Bauer, and Hans-Georg Meyer — Institute for Physical High Technology, Albert-Einstein-Straße 9, D-07745 Jena, Germany

Electromagnetic methods are widely used in geophysical exploration to detect conductivity anomalies, which are a marker for a variety of ore deposits. Transient ElectroMagnetics (TEM) is a standard method for ground based and airborne exploration: A rectangular-like excitation field (primary signal) generates eddy currents in the ground and the corresponding secondary field of the decaying eddy is measured after the primary field is switched off. By this means, an apparent resistivity depth profile can be calculated.

Since SQUIDs are much more sensitive than coils at low frequencies and measure the B field directly they can extend the exploration depth in TEM significantly. IPHT Jena has developed HTS and LTS SQUID systems for TEM. One major demand for such a system is a high slew rate of several milli-Tesla/second since the Flux Locked Loop has to follow the steep transients of the primary signal. The systems are designed to be robust and easy to handle. A ruggedised, water proof box holds the control unit and power supply, the cryostat is placed in a shock absorbing container, the working points of the SQUIDs are tuned automatically by using a microprocessor. The magnetic field resolution is $20\mathrm{fT}/\sqrt{Hz}$ for the LTS SQUID system. The HTS SQUID system uses an ac bias technique to reach a noise floor of $30\mathrm{fT}/\sqrt{Hz}$ above 100Hz and $100\mathrm{fT}/\sqrt{Hz}$ at 1Hz. The superiority of the SQUIDs compared to conventional induction coil type and fluxgate sensors has been demonstrated on many targets. The LTS SQUID systems are now used in routine exploration work.

TT 8.41 Mon 14:00 Poster A

Fabrication of Josephson based superconducting quantum devices — •Tobias Heimbeck, Sonia Dandl, 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 Josephson coupling energy larger than the charging energy are called flux qubits. The qubit states are given by a symmetric superposition of states corresponding

to clockwise and counter clockwise circulating currents at a flux bias of half a flux quantum. We have fabricated superconducting flux qubits based on $Al/AlO_x/Al$ tunnel junctions, using electron beam lithography and shadow evaporation technique. Junctions with areas down to $100 \times 100\,nm^2$ could be realized . A crucial point was to establish and optimize the oxidation process for the lower electrode as well as to design the electromagnetic environment by suitable shunting capacitors and resistors. We established a process allowing to fabricate on chip $Al/AlO_x/Al$ capacitors. Using either optical or electron beam lithography we realized capacitors with a specific capacitance of $14\,fF/\mu m^2$. And resistance values well above $100\,M\Omega$ for capacitor areas up to $1000\,\mu m^2$. These capacitors are suited as on chip shunting capacitors for flux qubits, isolating the qubits from environmental noise sources.

This work was supported by the DFG via SFB 631.

TT 8.42 Mon 14:00 Poster A

Numerical simulation of an oscillator driven by a superconducting single electron transistor — •Michael Marthaler and Gerd Schön — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We study a quantum oscillator, capacitively coupled to a superconducting single electron transistor (SSET). Transitions between charge states on the island lead to excitations in the oscillator. Our analysis focuses on the behavior of the oscillator in the vicinity of the JQP resonance. Using a dressed state approach we can calculate the probability distribution of the oscillator states. As proposed by NEC-Group (Astafiev *et. al*) one should get a laser-like behavior if the oscillator is at resonance with the Josephson oscillations in the SSET. We were able to verify this.

TT 8.43 Mon 14:00 Poster A

Interaction-Induced Renormalization of Andreev Reflection — •Wolfgang Belzig, Mikhail Titov, and Markus Müller — Department of Physics, University of Konstanz, 78457 Konstanz

Understanding the influence of interaction effects is of fundamental importance in the study of electronic transport through low-dimensional nanostructures. In our work we analyze the charge transport between a one-dimensional weakly interacting electron gas and a superconductor within the scaling approach in the basis of scattering states. We derive and solve the renormalization group equations [1], which fully take into account the intrinsic energy of the scattering matrix due to Andreev reflection. We find a strong renormalization of the Andreev reflection phase even for a prefectly transparent normal metal-superconductor interface. We discuss the effect of this unexpected phase renormalization on the supercurrent through a long superconductor-normal metal-superconductor junction. Our results predict a high sensitivity of the interaction-induced suppression of the Andreev conductance on the normal-state resistance, and thereby provide a possible explanation of experiments with single-walled carbon-nanotube/superconductor junctions [2].

[1] M. Titov, M. Müller, and W. Belzig, Phys. Rev. Lett. **97** 237006 (2006).
[2] A. F. Morpurgo, J. Kong, C. M. Marcus, and H. Dai, Science **286**, 263 (1999).

TT 8.44 Mon 14:00 Poster A

Transversal Flux-Transformer Effect in Narrow Superconducting Channels of a-$Nb_{0.7}Ge_{0.3}$ — •F. Otto[1], M. Frisch[1], A. Helzel[1], A. Bilušić[1], D. Babić[2], C. Sürgers[3], and C. Strunk[1] — [1]Inst. for Exp. and Appl. Physics, Univ. Regensburg, Germany — [2]Dept. Physics, Univ. Zagreb, Croatia — [3]Phys. Inst. and DFG Center for Funct. Nanostr. (CFN), Univ. Karlsruhe, Germany

We study nonlocal vortex transport in mesoscopic amorphous $Nb_{0.7}Ge_{0.3}$ samples. A dc current I is passed through a wire connected via a perpendicular channel, of a length $L = 2 - 5\,\mu m$ and width $w = 0.1 - 2\,\mu m$, with a pair of voltage probes where a nonlocal response V_{nl}/I is measured. In our low-pinning a-$Nb_{0.7}Ge_{0.3}$, the effect appears in more than half of the superconducting phase diagram, i.e. everywhere where the vortices can be moved easily enough to induce dissipation at very low currents. The maximum of $R_{nl} = V_{nl}/I$ for a given temperature occurs at an L-independent magnetic field and is proportional to $1/L$. The influence of the vortex-matter viscosity alone is more easily studied in the limit $T \to T_c$, where pinning effects are negligible. We present a detailed study of the T- and w-dependence of the effect.

TT 8.45 Mon 14:00 Poster A

Transport of magnetic flux quanta by Surface Acoustic Waves — •Munise Rakel, Fabian Jachmann, and Carsten Hucho — Paul-Drude-Institut, Hausvogteiplatz 5-7, 10117 Berlin

We report on the interaction between a traveling surface acoustic wave (SAW) and the ensemble of magnetic flux quanta (vortices) in a type II superconductor in the Shubnikov phase. The possibility of manipulating the motion and density of single flux quanta by a dynamic external parameter (no direct contact) has far reaching technological consequences. Here we investigate a thin film of superconducting $YBa_2Cu_3O_7$ on a piezoelectric substrate. The SAWs were generated by applying an RF-current into interdigital transducers (IDTs). This results in a DC-voltage peak in the superconducting film near the critical temperature T_c which shows both symmetric and antisymmetric contributions in the presence of a magnetic field. While the symmetric background can be related to the well known ac/dc-conversion effect, the antisymmetric part is ascribed to the SAW induced directed motion of vortices. The ultrasonic strain wave itself acts like a dynamic pinning grid to which the vortices are forced to couple. This SAW related vortex drag is, therefore, most prominent in a very narrow temperature and field range right at the boundary between the vortex glass phase and the thermally activated flux flow regime.

TT 8.46 Mon 14:00 Poster A

Microscopic study of vortex pinning in YBCO thin films — •Tetyana Shapoval, Volker Neu, Ulrike Wolff, Elke Backen, Maria Sparing, Ruben Huehne, Bernhard Holzapfel, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

The direct microscopic imaging of flux lines by means of low-temperature MFM was applied to study the vortex pinning mechanism at natural and artificial defects in high temperature superconducting films. A low-temperature scanning probe microscope (Omicron Cryogenic SFM) allows measurements in UHV combined with magnetic fields of 7 T (vertical) and 3 T (transversal). Flux lines have been successfully imaged on a pure YBCO film as well as on a YBCO film grown on a template with gas phase prepared Y_2O_3 nanoparticles. The investigated films with a mean roughness less than 10 nm were deposited by off-axis PLD and cooled down in the microscope to 7.7 K in a magnetic field prior to imaging. The number of vortices observed corresponds to the theoretically expected one. The vortex distribution was compared with the topography. The *in situ* transport measurements allow an estimation of the pinning strength at the different defects present in the sample. For future studies on chemical deposited films a mechanical polishing procedure is developed to obtain sufficiently smooth sample surfaces.

TT 8.47 Mon 14:00 Poster A

Comparative experimental and theoretical study of flux dynamics in homogeneous high-T_c superconducting films — Carolina Romero-Salazar[1], Christian Jooss[1], and •Omar Hernandez-Flores[2] — [1]Institut fuer Materialphysik, Friedrich Hund Platz 1, 37077 Goettingen, Germany — [2]Instituto de Fisica, Universidad Autonoma de Puebla, Apdo. Post. J-48, Puebla, Mexico

We investigate the magnetic flux, current and electric field distributions for flux creep, in a nearly single crystalline thick YBaCuO film via magneto-optical imaging, employing a method presented recently [1].

Additionally, we calculate numerically the induced electric field distributions in finite thickness films, in perpendicular geometry and flux creep regime. The nonlocal model is based on the flux distribution in the critical state and enables us to investigate the geometry-sample dependence of physical properties of superconducting films.

A quantitative and qualitative agreement between theoretical and experimental distributions was obtained. Understanding the vortex dynamics in homogeneous superconducting films, provides a necessary background to study inhomogeneous materials.

[1] Ch. Jooss and V. Born *Phys. Rev. B* **73**, 094508 (2006).

TT 8.48 Mon 14:00 Poster A

Matching in flux-line lattice pinned by triangular pinning array with disorder — •M. Oettinger[1], J. Eisenmenger[1], C. Pfahler[1], A. Plettl[1], U. Wiedwald[1], L. Han[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

The interaction of a flux line lattice (FLL) with quasiperiodic pinning arrays recently attracted a lot of attention. A different type of order is found for self-organized patterns, as, e.g., a weakly disturbed FLL itself, which is characterized by a short-range triangular order but a missing directional long-range order. We prepared arrays of nanoscaled artificial pinning centers (APCs) with such order into Nb thin films. The APCs are formed by depositing Nb onto substrates covered with Si nanopillars or metal nanospheres with diameters of 10 – 50 nm. The mutual distance of pillars and spheres is about 100 nm. Nanospheres are produced by using the self-organization of inverse micelles formed by diblock-copolymers, whose core is loaded with a metal precursor, e.g., Au or FePt. Si nanopillars are formed by using an array of gold nanospheres as an etching mask during reactively ion etching a Si substrate. In this way, the pattern of the nanoparticle array is transferred onto the Si substrate. The resulting lattice of APCs, formed by the Si pillars or metal nanospheres perforating the Nb film, mirrors the order of the micellar array. By nanoshaping APCs of different types, sizes and mutual distances, we can investigate specific influences on magnetic and electrical transport properties.