TT 10: Poster Session: Superconductivity

Time: Monday 14:00–18:00 Location: P4

TT 10.1 Mon 14:00 P4

Growth of YBCO thin films and their interaction with gold nano clusters — •Christian Katzer[1], Ralf Erlebach[1], Daniel Kuhwald[1], Peter Michalowski[1], Frank Schmidl[1], Ingo Uschmann[2], and Paul Seidel[1] — [1]Friedrich-Schiller-University Jena, Institute of Solid State Physics, Helmholtzweg 5, 07743 Jena, Germany — [2]Friedrich-Schiller-University Jena, Institute of Optics and Quantum Electronics, Max-Wien-Platz 1, 07743 Jena, Germany

Using Pulsed Laser Deposition (PLD) our team is able to fabricate and examine Yttrium-Barium-Copper-Oxide (YBCO) thin films of high quality. A particular point of investigation is the influence of an in situ pre-deposited gold film. While growing the superconducting film one can achieve a formation of gold nano clusters in an YBCO matrix through heating of the initial gold layer. We studied the temperature dependence of the resistance in respect to the YBCO film thickness for various gold layers. Furthermore the critical current density at 77 K and their temperature dependence will be compared with the one of non-modified YBCO thin film structures.

TT 10.2 Mon 14:00 P4

Characterization of $YBa_2Cu_3O_{7-x}$ -grain boundary contacts with Au-clusters — •Daniel Kuhwald, Christian Katzer, Ralf Erlebach, Matthias Schmidt, Veit Grosse, Frank Schmidl, and Paul Seidel — Friedrich-Schiller-University Jena, Institute of Solid State Physics, Helmholtzweg 5, 07743 Jena, Germany

In the course of the work $YBa_2Cu_3O_{7-x}$ (YBCO) layers have been deposited epitaxially onto a bicrystalline strontium titanate substrate with an intermediate gold layer. During the deposition of YBCO the gold forms clusters, changing the crystallographic properties of the superconducting layer and especially the emerging grain boundary. In this way Josephson-junctions and simple DC-Superconducting Quantum Interference Devices (SQUIDs) have been produced both with and without gold nanoclusters and their electrical properties were investigated and compared among each other. We present the dependency of the critical current and the $I_C R_N$-product on the temperature. Furthermore the behaviour of the junctions in external magnetic fields and under microwave irradiation is shown. In all cases we discuss and compare the behaviour of junctions with and without gold nanoclusters.

TT 10.3 Mon 14:00 P4

Integration of predefined gas-phase condensed nanoparticles into $YBa_2Cu_3O_{7-\delta}$ thin film multilayers — •Maria Sparing, Tom Thersleff, Jens Hänisch, Ingolf Mönch, Ruben Hühne, Sebastian Fähler, Bernd Rellinghaus, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box: 270116, 01171 Dresden, Germany

The critical current density J_c in $YBa_2Cu_3O_{7-\delta}$ (YBCO) thin films, which limits their application in external magnetic fields, can be enhanced by the introduction of artificial pinning centers e.g. created by non-superconducting nanoparticles and surrounding defects and strain states. A controlled preparation of nanoparticles with adjustable properties is required in order to understand the correlation between the superconducting characteristics, the particles and the defect structure. Isolated particles with a predefined diameter in the range of 10 nm and an independently chosen areal density can be prepared via dc-magnetron sputtering in an inert gas flow. Here we present the integration of such gas phase condensed Hafnium nanoparticles into PLD-grown YBCO thin film multilayers in a combined PLD-Sputtering system. These heterostructures were investigated by TEM on cross sectional FIB lamellae. The influence of the areal density and the particle volume content on the structural and superconducting properties of YBCO thin films is discussed. Furthermore, advantages and consequences of this new technique for the preparation of nanoparticle thin film heterostructures are evaluated.

TT 10.4 Mon 14:00 P4

Phase formation and critical current density in YBCO based quasimultilayers prepared by off-axis pulsed laser deposition — •Elke Reich[1,3], Thomas Thersleff[1,3], Ruben Hühne[1], Kazumasa Iida[1], Ludwig Schultz[1,2,3], and Bernhard Holzapfel[1,3] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]TU Dresden, Department of Physics, Institute for Physics of Solids, D-01062 Dresden, Germany — [3]TU Dresden, Department of Mechanical Engineering, Institute for Material Science, D-01062 Dresden, Germany

The use of coated conductors for power applications requires the improvement of the critical current densities in high magnetic fields. Significant research effort has been undertaken to investigate and enhance the flux pinning forces of high-temperature superconducting thin films. One possibility is the introduction of nano-sized defects into the superconductor thereby creating quasimultilayers of a complete superconducting layer and an incomplete dopant layer. In this work we present the phase formation and critical current density characteristics of YBCO based quasimultilayers doped with the double perovskite phase $Y_2Ba_4CuMO_y$ (Y2411) (M=Zr and Nb). We will show evidence for a reaction from the Y2411 phase to a simple Yttrium doped perovskite $Ba(M_{1-x}Y_x)O_3$ during film deposition. These second-phase inclusions clearly enhance J_c in high magnetic fields.

TT 10.5 Mon 14:00 P4

Low-temperature MFM based on piezoresistive cantilevers — Philip Meiser, •Michael R Koblischka, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P.O.Box 151150, D-66041 Saarbrücken, Germany

We present the construction of a low-temperature magnetic force microscope (MFM) operating at temperatures down to 1.5 K and in fields up to 5 T. The MFM is based on commercial piezoresistive cantilevers, coated with 30 nm-thick layers of CoCr. In this contribution, we show details of the construction of the home-built MFM head and discuss the dependence of the piezoresistive signal, the resonance frequency, the obtained resonance curves and the quality facors on temperature. Furthermore, we present measurements on magnetite thin films and superconducting ring structures based on Pb thin films.

TT 10.6 Mon 14:00 P4

$NdBa_2Cu_3O_x$ nanowires grown in anodized alumina templates by microwave heating — •Michael R Koblischka, Anjela Koblischka-Veneva, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P.O.Box 151150, D-66041 Saarbrücken, Germany

Nanowires of $NdBa_2Cu_3O_x$ (NdBCO) are grown employing commercial anodized alumina templates (pore diameters of 10 nm and 100 nm, overall thickness of 50 μm) and pre-prepared NdBCO powders. The heating was performed employing a kitchen-type microwave furnace at a power of 550 W for 5 min. This treatment is sufficient to melt the NdBCO powder on top of the alumina template. In contrast to previous experiments using a laboratory furnace at a temperature of 1050 °C, the temperature here is not surpassing 450 °C. As a result, the templates remain fully flat and the structure of the nanopores is not affected by the heat treatment. An additional oxygen annealing step is required to obtain superconducting nanowires. Superconductivity with a transition temperature of 88 K is confirmed by means of magnetic susceptibility measurements (SQUID, AC susceptibility). The resulting nanowires are analyzed in detail employing electron microscopy (SEM, TEM).

TT 10.7 Mon 14:00 P4

Mechanically alloyed in-situ MgB_2: Aspects of powder preparation towards an industrial scale wire preparation — •Marko Herrmann[1], Wolfgang Häßler[1], Christian Rodig[1], Margitta Schubert[1], Ania Kario[1], Konstantin Nenkov[1], Juliane Scheiter[1], Ludwig Schmolinga[2], André Aubele[3], Bernd Sailer[3], Klaus Schlenga[3], Bernhard Holzapfel[1], and Ludwig Schultz[1] — [1]IFW Dresden, Institute for Metallic Materials, Dresden, Germany — [2]Bruker HTS GmbH, Alzenau, Germany — [3]Bruker EAS GmbH, Hanau, Germany

During the powder-in-tube preparation using sheath materials, e.g. Monel or CuNi alloys, it is necessary to recover the metallic sheath in order to reduce work hardening and allow for further deformation. In combination with a mechanically alloyed in-situ precursor this intermediate heat treatment is a sensitive processing step. Due to the high reactivity of the nanocrystalline precursor an unintended MgB_2 formation starting at around 350°C is observed. With ongoing phase

formation the hardness of the precursor is increasing and therefore limiting the deformability of the wire composite.

In order to allow for a reliable wire preparation this paper concentrates on the characterization of the reactivity of mechanically alloyed precursor powders using x-ray diffraction studies with subsequent Rietveld analysis. Experimental results of transport measurements and microstructural investigations on MgB_2 bulk samples, wires and tapes prepared with precursor powders of different processing, e.g. variation of milling energy and carbon addition, will be discussed.

TT 10.8 Mon 14:00 P4

Fabrication of superconducting MgB_2 thin films and characterization by THz-transmission spectroscopy — Savio Fabretti[1], •Martin Scheuch[2], Tobias Kampfrath[2], Christian Frischkorn[2], Martin Wolf[2], Patrick Thomas[1], and Andy Thomas[1] — [1]Thin films and physics of nanostructures, Bielefeld University — [2]Fritz-Haber-Institut der MPG, Faradayweg 4-6, 14195 Berlin

Superconducting MgB_2 thin films were fabricated by magnetron rf and dc co-sputtering on heated silicon and diamond substrates. They were annealed ex-situ for one hour at 650 °C. The superconducting phase transition was characterized contactless by means of terahertz time-domain spectroscopy in the frequency range from 0.8 to 4 THz. For this purpose, amplitude- and phase-resolved transmission measurements of the MgB_2 films for temperatures between 5 and 50 K were performed to extract the complex conductivity. The data show that both samples are homogeneous on a length scale of millimeters and superconducting below a transition temperature of about 22 K. This paves the way to investigate charge-carrier dynamics in MgB_2 with time-resolved THz spectroscopy.

S.F. and A.T. are supported by the NRW MIWF.

TT 10.9 Mon 14:00 P4

Thermodynamic Investigations and Superconductivity in $A(Fe_{1-x}Co_x)_2As_2$ (A = Ba, Ca, K) Systems — •M. Abdel-Hafiez, L. Harnagea, S. Singh, S. Aswartham, C. Nacke, G. Friemel, M. Kumar, C. Hess, S. Wurmehl, R. Klingeler, A.U.B. Wolter, and B. Büchner — Leibniz Institut für Festkörper- und Werkstoffforschung IFW Dresden, 01069 Dresden, Germany

We report on thermodynamic properties of single crystals $A(Fe_{1-x}Co_x)_2As_2$ (A = Ba, Ca, K) combining magnetization, specific heat and resistivity investigations. In comparison to a similar phase diagram for Co-doped Ba122 and Ca122, which exhibits split quasi-continuous magnetic and structural transitions upon Co-doping, the parent compound KFe_2As_2 lacks such structural/magnetic transitions completely. Furthermore, its superconducting transition temperature has been determined to be around 3.8 K, while Ca122 and Ba122 systems only become superconducting upon doping. In addition to these doping-dependent studies, thorough investigations on the magnetic phase diagram have been performed on individual compounds of all three systems. The Werthamer-Helfand-Hohenberg model was used to determine the upper critical field for different directions $H||c$ and $H||(ab)$.

TT 10.10 Mon 14:00 P4

A quasi-optical setup for sub-terahertz ESR spectroscopy: application to superconducting iron pnictides — •R. Zahn[1], A. Alfonsov[1], G. Lang[1], F. Lipps[1], V. Kataev[1], S. Aswartham[1], S. Wurmehl[1], J. S. Kim[2], J. Deisenhofer[3], H.-A. Krug von Nidda[3], A. Loidl[3], and B. Büchner[1] — [1]IFW Dresden, D-01069 Dresden, Germany — [2]Pohang University of Science and Technology, Pohang, Korea — [3]Center for Electronic Correlations and Magnetism, Augsburg University, D-86135 Augsburg, Germany

We present a high-sensitivity quasi-optical electron spin resonance (ESR) setup working in a frequency range of 250 - 800 GHz. Combination of optical means of propagation with a low-loss corrugated waveguide enables full control of the polarisation of the microwaves, which is essential for the high-sensitivity ESR measurements. The detection is realised by Millimeterwave Vector Network Analyzer. The setup is operational with a magneto-cryostat with a magnetic field up to 17 T and in a temperature range of 2 - 300 K. It enables to measure weak ESR signals not only from the insulating samples transparent for microwaves but also from metallic samples where the penetration of the microwaves is restricted by the skin depth. As an example of the application of this setup we show the temperature- and frequency-dependent ESR measurements on small single crystals of $(Eu,Ba)(Fe,Co)_2As_2$ superconductor. We find that the Eu^{2+} ESR is sensitive to the structural and magnetic phase transitions occurring in this material. We discuss the interaction between the Eu- and Fe-subsystems and its relevance for the understanding of the properties of these novel superconductors.

TT 10.11 Mon 14:00 P4

Low temperature specific heat and thermal expansion measurements of $Ba(Fe_{1-x}Co_x)_2As_2$ single crystals in high magnetic fields — •Philipp Burger[1,2], Frédéric Hardy[1], Devang Joshi[1], Peter Adelmann[1], Doris Ernst[1], Rainer Fromknecht[1], Peter Schweiss[1], Thomas Wolf[1], and Christoph Meingast[1] — [1]Institut für Festkörperphysik, Karlsruher Institut für Technologie, 76021 Karlsruhe, Germany — [2]Fakultät für Physik, Karlsruher Institut für Technologie, 76128 Karlsruhe, Germany

Low temperature specific heat and thermal expansion measurements have been performed on underdoped (T_c=12.7 K), optimally doped (T_c=24.5 K) and overdoped (T_c=9.1 K) $Ba(Fe_{1-x}Co_x)_2As_2$ single crystals in magnetic fields up to 14 T applied both parallel and perpendicular to the Fe layers. Whereas the specific heat anomalies in under- and over-doped crystals are significantly reduced in size by the magnetic field, the size of the thermal expansion anomalies are hardly affected by the field. The electronic Grüneisen parameters associated with the superconducting properties are calculated from the data and will be examined for signs of quantum criticality. Further, the anisotropy associated with the superconducting state, as well as the low temperature field dependence of the Sommerfeld coefficients will be discussed.

TT 10.12 Mon 14:00 P4

High resolution thermal expansion of isovalently doped $BaFe_2(As_{1-x}P_x)_2$ — •Anna Böhmer[1,2], Philipp Burger[1,2], Devang Joshi[1], Frédéric Hardy[1], Peter Schweiss[1], Christoph Meingast[1], Shigeru Kasahara[3], Takahito Terashima[3], Takasada Shibauchi[4], and Yuji Matsuda[4] — [1]Karlsruher Institut für Technologie, Institut für Festkörperphysik, 76021 Karlsruhe, Germany — [2]Karlsruher Institut für Technologie, Fakultät für Physik, 76131 Karlsruhe, Germany — [3]Research Center for Low Temperature and Materials Sciences, Kyoto University, Kyoto 606-8501, Japan — [4]Department of Physics, Kyoto University, Kyoto 606-8502, Japan

In the intensively studied 122-family of iron-based superconductors, superconductivity can be induced not only by charge-doping but also by isoelectronic substitution in the FeAs-layer ("chemical pressure") and by hydrostatic pressure.

We have performed high-resolution thermal expansion measurements between 5 K - 300 K on under- and optimally doped $BaFe_2(As_{1-x}P_x)_2$ single crystals with a T_c up to 30 K. They allow us to study the uniaxial pressure derivatives of their spin-density wave (structural) and superconducting transition temperatures. Parallels to electron doped $Ba(Fe_{1-x}Co_x)_2As_2$ will be drawn. Structural parameters derived from four circle X-ray diffraction measurements contribute to our comparative study of physical pressure and P-doping in $BaFe_2As_2$.

TT 10.13 Mon 14:00 P4

Single-Crystal Growth of $Sr_{1-x}K_xFe_2As_2$ superconductors using Sn flux — •Devang Joshi, Anna Böhmer, Frederic Hardy, Peter Adelmann, Doris Ernst, Thomas Wolf, Rainer Fromknecht, Peter Schweiss, and Christoph Meingast — Institute für Festkörperphysik, Karlsruher Institute für Technologie, 76021 Karlsruhe, Germany

Single crystals of $Sr_{1-x}K_xFe_2As_2$ were grown by a high-temperature solution growth method using Sn flux. Stochiometric amounts of FeAs, Sr, K and Sn (1:20) were put in alumina crucibles, which were then sealed in iron crucibles under argon atmosphere. The iron crucibles were further sealed in evacuated quartz tubes. The total assembly was then heated to 900 °C followed by slow cooling to 450 °C in roughly 15 days. The single crystals were separated from the Sn flux using a centrifuge, and the K-contents of the single crystals were determined using EDAX. The spin-density-wave and superconducting transitions in these crystals were further characterized using magnetic SQUID, high-resolution thermal expansion and specific heat measurements.

TT 10.14 Mon 14:00 P4

Optical Investigations on the Effect of Phosphorous Substitution in $EuFe_2(As_{1-x}P_x)_2$ Single Crystals — •Sina Zapf[1], Geoffrey Chanda[1], Dan Wu[1], Hirale S. Jeevan[2], Philipp Gegenwart[2], and Martin Dressel[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]I. Physikalisches Institut, Univer-

sität Göttingen, Germany

The ab-plane optical, magnetic and transport properties of $EuFe_2(As_{0.88}P_{0.12})_2$ single crystals have been investigated and were compared to those of $EuFe_2As_2$ (T_{SDW}=189 K) and the superconducting $EuFe_2(As_{0.82}P_{0.18})_2$ (T_c=28 K). We identify in the case of $x = 0.12$ a spin density wave (SDW) transition below 110 K.
Isovalent P substitution on the As site depresses the SDW in $EuFe_2As_2$. For $x = 0.18$, the SDW has already disappeared. The resistivity curve of our $x = 0.12$ sample shows an anomaly below 110 K with a different shape compared to the SDW feature of the parent compound. However, the Drude-Lorentz analysis on the optical conductivity spectra indicates a SDW gap formation similar to $EuFe_2As_2$. We observe a drop in reflectivity between 170 and 1200 cm^{-1} as well as the transfer of the spectral weight up to 3500 cm^{-1}. The latter effect can be understood as a many-body (interband) interaction in the multiband system. The magnetic ordering of the Eu^{2+} spins and thus the interplay between magnetism and superconductivity are examined by susceptibility measurements. We found a similar ordering as in the parent compound with a decrease of T_N down to 16.5 K.

TT 10.15 Mon 14:00 P4

^{75}As NMR study on (Eu/Sr)(Fe/Co)$_2$As$_2$ single crystal. — •Rajib Sarkar[1], Panchanana Khuntia[1], Michael Baenitz[1], Ramesh Nath[3], Hirale Jeevan[2], Philipp Gegenwart[2], and Frank Steglich[1] — [1]MPI for Chemical Physics of Solids, 01187 Dresden, Germany — [2]I. Physik. Institut, Georg-August-Universität Göttingen, D-37077 Göttingen, Germany — [3]IISER-TVM, Trivandrum-695016, India

The AFe_2As_2 (122)(A= Sr, Ba, Ca Eu) systems is the focus of research interest because of high temperature superconductivity (SC) with T_c's up to =38 K. The $EuFe_2As_2$ compound is special because of highest Fe SDW transition of T_{sdw}=190 K among the pnictides [1]. In addition at T_N=19 K antiferromagnetic order of Eu^{2+} shows up. Moreover Eu^{2+} is magnetic with S=7/2, while Ba^{2+}, Sr^{2+} and Ca^{2+} are non-magnetic ions [2]. Interestingly, the Fe SDW is completely suppressed in $Eu_{0.5}K_{0.5}Fe_2As_2$ and SC is found below T_c=32 K. However unlike the other 122 system SC could not be achieved only by substitution of Co^{2+} at the Fe site, may be due to the Eu^{2+} AFM ordering. Nevertheless with the 80% Sr doping at the Eu^{2+} site and the optimal doping of Co at the Fe site, one can get the SC with T_c=20 K[3, 4]. Being a local probe, NMR is a very useful tool to study the microscopic properties of these Fe-pnictides. Here we report the ^{75}As field sweep NMR investigations superconducting (Eu/Sr)(Fe/Co)$_2$As$_2$ single crystals.
[1] Phys. Rev. B 78, 092406 (2008).
[2] Phys. Rev. B 82, 054525 (2010).
[3] J. Phys.: Condens. Matter 22 (2010) 235701.
[4] Sarkar et. al. to be published.

TT 10.16 Mon 14:00 P4

Superconductivity and local-moment magnetism in Eu(Fe$_{0.89}$Co$_{0.11}$)$_2$As$_2$ — •Shuai Jiang[1,2], Philipp Gegenwart[1], and Guanghan Cao[2] — [1]I. Physikalisches Institut, The University of Goettingen, Goettingen, Deutschland — [2]Department of Physics, Zhejiang University, Hangzhou, China

Here we report the anisotropic measurements of resistivity and magnetization under magnetic fields on a $Eu(Fe_{0.89}Co_{0.11})_2As_2$ single crystal. We observed a resistivity drop at T_c=21 K, which suggests a superconducting transition. The low-field magnetic susceptibility data also show the evidence of superconductivity. Instead of expected zero-resistance below T_c, a resistivity reentrance appears at 17 K under zero field, coincident with the magnetic ordering of Eu^{2+} moments. According to the temperature and field dependences of anisotropic magnetization, we propose there exists a helical magnetic structure for the Eu^{2+} spins. The external magnetic fields easily changes the helimagnetism into ferromagnetism with fully polarized Eu^{2+} spins, accompanying by disappearance of the resistivity reentrance. Therefore, superconductivity coexists with ferromagnetic state of Eu^{2+} spins under relatively low magnetic field. The magnetic and superconducting phase diagrams are finally finished for magnetic fields parallel and perpendicular to the basal plane.

TT 10.17 Mon 14:00 P4

Applicability of the vitual crystal approximation to the band structure of Fe pnictides — •Alexander Yaresko — Max Planck Institute for Solid State Research, Stuttgart, Germany

Band structure calculations were performed for supercells of $BaFe_2As_2$ with an Fe ion substituted by 3d (Mn, Co) or 4d (Ru) transition metal one. Comparison of the Fermi surfaces to those calculated for electron (hole) doped $BaFe_2As_2$ using the virtual crystal approximation shows that the variation of the size of the Fermi surfaces upon Co (Mn) substitution can be well reproduced by corresponding doping. Substitution of Fe by Ru does not affect the size of the Fermi surfaces but leads to an appreciable increase of the band width. The strength of intra- and inter-band impurity scattering is estimated.

TT 10.18 Mon 14:00 P4

Magnetic and orbital order in a spin-fermion model for pnictides — •Thomas Prestel and Maria Daghofer — Institute for Theoretical Solid State Physics, IFW Dresden, 01171 Dresden, Germany

We study a spin-fermion model for iron pnictides [1] that couples itinerant electrons in the xz and yz orbitals to a local spin degree of freedom, which is modelled as a classical spin.We use classical Monte Carlo simulation as well as Exact diagonalization technique to investigate this model. At half filling, corresponding to undoped compounds, we find Flux-phase magnetic ordering rather than the experimentally observe C-type ordering, while slight doping as well as a magnetic single-ion anisotropoy stabillize the observed magnetic phase. We study this phase competition. We also study the model supplemented by local impurities and find the impurities to have a small impact on the orbital occupation of surrounding sites.
[1] W.-G. Yin, C.-C. Lee, W. Ku, PRL **105**, 107004 (2010)

TT 10.19 Mon 14:00 P4

Theory of normal state incoherence in iron superconductors. — •Luis Craco and Stefano Leoni — Physical Chemistry - Technical University Dresden

The precise nature of unconventional superconductivity in Iron superconductors is presently a hotly debated issue. An issue for theory is (a) whether these materials are incoherent, bad metals in the normal state and (b) how close they are to Mottness?

In this poster, we will show our recent efforts to describe the correlated nature of Fe-based superconductors. We will highlight how a combination of first principles and many-body calculations allows us to interpret and/or predict experimental results. In particular, we will show our results for spectroscopic [1], electrical [2] and thermal transport [3] of tetragonal-FeSe superconductor, all found to be in good agreement with extant data. We will also present a comparative study of the electronic states of tetragonal- and hexagonal-FeSe [4], showing normal state incoherence in both structural phases and orbital-selective Mott localization in hexagonal FeSe.
[1] L. Craco, M.S. Laad, and S. Leoni, arXiv:0910.3828.
[2] L. Craco, M.S. Laad, and S. Leoni, Europhys. Lett. 91, 27001 (2010).
[3] L. Craco and M.S. Laad, arXiv:1001.3273.
[4] L. Craco and S. Leoni, submitted to Europhysics Letters.

TT 10.20 Mon 14:00 P4

Structural and magnetic properties of the FeAs-based superconductors — •Navid Qureshi[1], Johanna Brand[1], Yvo Drees[1], Jochen Werner[2], Sabine Wurmehl[2], Christian Hess[2], Rüdiger Klingeler[2], Bernd Büchner[2], María Teresa Fernández-Díaz[3], Paul Steffens[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Festkörper- und Werkstoffforschung, Dresden — [3]Institut Laue Langevin, Grenoble

The recently discovered family of oxypnictides superconductors has focused the interest of the scientific community as they represent the first non-copper-oxide based layered superconductors reaching a T_c of 55 K. We have combined high-flux and high-resolution neutron and x-ray powder diffraction experiments to study the magnetic and crystal structure of the $REO_{1-x}F_xFeAs$ series. For RE=La we may unambiguously determine the magnetic symmetry of the undoped material. Upon cooling through the structural and magnetic transitions, the pure and slightly doped materials exhibit anomalies in bond distances and in bond angles which reflect the general magnetophonon coupling in FeAs compounds. Furthermore, we have performed an inelastic neutron scattering study with polarized neutrons and linear polarization analysis on a $BaFe_2As_2$ single crystal, which may distinguish between the different directional components of the spin fluctuations. Energy scans at the magnetic zone centers (1 0 l) with l being an odd number reveal clear evidence for an anisotropic spin wave excitation at the magnetic zone centers, where the out-of-plane spin fluctuation component surprisingly sets in at lower energy than the in-plane component.

TT 10.21 Mon 14:00 P4

A method to contact individual microcrystalline oxypnictide single crystals — •Andreas Teichgräber, Christian Hess, Sabine Wurmehl, and Bernd Büchner — IFW Dresden

Despite the rapid general progress in fabricating large high-quality single crystals of pnictide superconductors, the controlled synthesis of 1111-type iron pnictide sample remains up to now possible only in the form of polycrystalline samples or tiny single crystals. This work describes a method to prepare electronic contacts on individual micrometer sized pnictide single crystals (extracted from a polycrystalline pellet of 1111-type iron pnictide samples). The micro-crystals were embedded in epoxy resin and subsequently contacted electrically using electron beam lithography. First test measurements demonstrate the applicability of the method which thus opens a new route to systematically investigate the electronic transport of 1111-type iron pnictide superconductors on individual single crystals over a wide range of compositions and doping levels.

TT 10.22 Mon 14:00 P4

Magnetic properties of $CeFeAs_{1-x}P_xO$ iron pnictides studied by Moessbauer spectroscopy — •Ph. Materne[1], J. Spehling[1], H.-H. Klauss[1], T. Dellmann[1], H. Maeter[1], H. Luetkens[2], R. Khasanov[2], A. Amato[2], A. Jesche[3], C. Krellner[3], and C. Geibel[3] — [1]Institut für Festkörperphysik, TU Dresden — [2]Laboratory for Muon-Spin Spectroscopy, Paul Scherrer Institut, CH-5232 Villigen, Switzerland — [3]Max-Planck-Institut für Chemische Physik fester Stoffe Dresden

The iron pnictide system $CeFeAs_{1-x}P_xO$ ($0 \leq x \leq 1$) exhibits a rich variety of electronic ground states ranging from coexisting long-range antiferromagnetic (AF) Fe-3d SDW order with AF Ce-4f order at low doping levels to short-range static Fe order with long-range FM Ce order for the midregime ($0.34 \leq x \leq 0.9$) to finally a non-magnetic ground state for high phosphorus concentrations, i.e. $x > 0.9$. By means of Moessbauer spectroscopy we determined the magnetic hyperfine field at the Fe site for representative phosphorus compositions. Our Moessbauer data are discussed in comparizon with results obtained from recent muon spin relaxation measurements.

TT 10.23 Mon 14:00 P4

^{75}As NMR Study of Iron Pnictides $RFeAsO_{1-x}F_x$ — •Marc Lux[1], Damian Rybicki[1], Thomas Meissner[1], Jürgen Haase[1], Grant Williams[2], and Chong Shen[2] — [1]Faculty of Physics and Earth Science, Leipzig University, Linnéstraße 5, 04103 Leipzig, Germany — [2]The MacDiarmid Institute, Industrial Research, P.O. Box 31310, Lower Hutt 5040, New Zealand

Since the recent discovery of superconductivity in iron pnictides they continuously attract an enormous amount of attention. Nuclear magnetic resonance (NMR) is a perfect tool to study their local properties through measurements of Knight shifts and relaxation rates. We present a ^{75}As NMR study of the $RFeAsO_{1-x}F_x$ family. We show temperature dependence of Knight shift, spin-spin and spin-lattice relaxation rates as a function of fluorine doping and orientation of the crystal structure with respect to the external magnetic field. The results are discussed and compared to other families of iron pnictides.

TT 10.24 Mon 14:00 P4

Ein Ferropniktid mit Phosphor: $Sr_{1-x}Na_xFe_2P_2$ — •Daniel Schmidt und Hans F. Braun — Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth

In der Arbeit wird ein Syntheseverfahren für die Verbindungen $Sr_{1-x}Na_xFe_2P_2$ (x = 0.2, 0.4, 0.6, 0.8) über die Precursorphase FeP dargestellt. Dieser Precursor wird ebenfalls hergestellt und kristallografisch mittels Röntgenpulverdiffraktometrie untersucht. Alle Syntheseschritte werden unter Inertgasatmosphäre durchgeführt. Die gefundene Fremdphase Fe_2P wird über ein magnetisches Reinigungsverfahren weitestgehend aus der Precursorprobe eliminiert. In Anlehnung an die Syntheseverfahren und Überlegungen der Eisenarsenidverbindungen stellt eine mit Phosphor hergestellte Verbindung eine isoelektrische Variante dar. Durch das Natrium werden Löcher in den Kristall eingebracht. Über Röntgenpulverdiffraktometrie werden die Änderungen der Gitterkonstanten des tetragonalen Gitters mit $ThCr_2Si_2$ -Struktur in Abhängigkeit des nominellen Natrium-Anteils beobachtet. Eventuelle magnetische oder supraleitende Übergänge konnten mit Hilfe der magnetischen Wechselfeldsuszeptibilität in einem Temperaturbereich zwischen 5 K und 260 K untersucht werden. Um Fremdphaseneffekte des noch in gewissem Mengenanteil vorhandenen Fe_2P zu erkennen, wurde diese Verbindung gezielt hergestellt und der magnetische Übergang aufgezeichnet.
Es konnte gezeigt werden, dass sich die Verbindungen prinzipiell herstellen lassen. Im Rahmen dieser Arbeit konnten jedoch keine magnetischen oder supraleitenden Übergänge gefunden werden.

TT 10.25 Mon 14:00 P4

Electronic Transport Properties of LiFeAs and Co doped LiFeAs — •Anne Bachmann, Dirk Bombor, Saicharan Aswaratham, Luminita Harnagea, Sabine Wurmehl, Christian Hess, and Bernd Büchner — Leibnitz Institute for Solid State and Materials Research, IFW Dresden, Germany

Electronic transport properties of the new unconventional superconductor LiFeAs and Co doped LiFeAs have been studied. Unlike in other iron arsenide superconductors this undoped compound exhibits no spin density wave but superconducting properties. Resistivity measurements show this transition at $T = 17\,\mathrm{K}$. We have studied the magnetoresistance of LiFeAs and extracted the $H_{c2}(T)$ phase diagram. In contrast to other Fe-As based compounds we find that in $LiFe_{1-x}Co_xAs$ electron doping suppresses superconductivity.

TT 10.26 Mon 14:00 P4

Effect of spin state, ordered moment and lattice anharmonicity on phonons in FeTe — Vladimir Gnezdilov[1,2], •Peter Lemmens[2], Yurii Pashkevich[3], Alexander Gusev[3], Karina Lamonova[3], Oleksandr Afanasiev[1], Sergei Gnatchenko[1], Vladimir Tsurkan[4,5], Joachim Deisenhofer[5], and Alois Loidl[5] — [1]ILTPE NAS, Ukraine — [2]IPKM, TU-BS, Braunschweig, Germany — [3]DonFTI NAS, Ukraine — [4]IAP AS, Moldova — [5]EP V, Univ. Augsburg, Germany

Investigations of FeTe single crystals as function of temperature show a relation between the magnitude of the ordered magnetic moment and the A_{1g} phonon linewidth at low temperatures. Based on microscopic modeling using density-functional theory this effect is attributed to the Fe spin state and orbital degeneracy. Our observations show the importance of orbital degrees of freedom for the Fe-based superconductors with large ordered magnetic moments.

Work supported by DFG.

TT 10.27 Mon 14:00 P4

Magnetic properties and superconductivity in $FeSe_{1-x}$ — •Stephan Knöner, Mariano de Souza, Amir Haghighirad, Sebastian Köhler, Wolf Assmus, and Michael Lang — Physikalisches Institut, Goethe-Universität, D-60438 Frankfurt(M), Germany

The discovery of superconductivity in Fe-pnictides has attracted enormous interest to this class of materials [1]. Among these, the binary alloy $FeSe_{1-x}$ with $T_c \approx 8.5$ K is particularly interesting due to its simple structure [2], which enables to explore the intrinsic properties of this class of superconductors. In this contribution, we report on synthesis, structural characterization, resistivity and magnetic measurements on the hitherto not explored δ'-phase of $FeSe_{1-x}$ [3]. In the case of samples with Fe excess as inclusions, we show that superconductivity survives despite the presence of a large saturated magnetic moment of up to $0.9\mu_B$/Fe. By an annealing process, the quality of the samples has been improved and the saturated magnetic moment is reduced dramatically to $0.1\mu_B$/Fe. Furthermore, the magnetization curves show clear presence of a hysteresis loop, typical for ferromagnets, also at temperatures below T_c. Our results indicate the robustness of superconductivity in $FeSe_{1-x}$ against ferromagnetic precipitations. Aspects relating to sample quality will also be discussed.
This work is part of the DFG priority program (SPP 1458).
[1] Y. Kamihara *et al.*, J. Am. Chem. Soc. **130**, 3296 (08).
[2] F.C. Hsu *et al.*, Proc. Natl. Acad. Sci. U.S.A. **105**, 14262 (08).
[3] M. de Souza *et al.*, Eur. Phys. J. B **77**, 101 (10).

TT 10.28 Mon 14:00 P4

Systematic investigations of the ternary system Fe-Se-Te — •Michael Schulze, M. Yasin Hacisalihoglu, Christian G.F. Blum, Christian Hess, Manoj Kumar, Anja U.B. Wolter, Sabine Wurmehl, and Bernd Büchner — IFW Dresden, Helmholtzstraße 20, 01069 Dresden

Among iron based superconductors the iron chalcogenides gain special attention due to the discovery of superconductivity in the Fe-Se-system by Hsu et al. [1]. The highest critical temperature in the so called 11-systems was first observed by Sales et al. [2] in a $FeSe_{0.5}Te_{0.5}$-sample. This poster presents a systematic investigation of the the ternary sys-

tem Fe-Se-Te by means of powder diffraction, magnetization and transport measurements.
[1] Hsu et al., Proc. Natl Acad. Sci. USA 105, 14262 (2008)
[2] Sales et al., Phys. Rev. B 79, 094521 (2009)

TT 10.29 Mon 14:00 P4

Electronic properties across the first-order phase transition in $Fe_{1.05}Te$ — •Sahana Rössler[1], Dona Cherian[2], Sasidharan Harikrishnan[2], Handadi L. Bhat[2], Suja Elizabeth[2], John A. Mydosh[3], Frank Steglich[1], and Steffen Wirth[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnizer Straße 40, 01187, Dresden, Germany — [2]Department of Physics, Indian Institute of Science, Bangalore 560012, India — [3]Kamerlingh Onnes Laboratory, Leiden University, P. O. Box 9504, 2300 RA Leiden, The Netherlands

We present scanning tunneling microscopy and spectroscopic (STM/S) studies on $Fe_{1.05}Te$ single crystals. In this compound, the superconductivity appears upon Se doping and the physical properties are found to be extremely sensitive to non-stoichiometry and disorder [1]. In our FeTe crystals, a first-order phase transition is observed around 57 K in the resistivity, magnetization, and the specific heat measurements. This transition is associated with a structural transition from a tetragonal $P4/nmm$ to a monoclinic $P2_1/m$ space group. At this temperature, the compound becomes antiferromagnetically ordered and the temperature dependence of the resistivity changes from log $(-T)$ to T^2. This observation suggests that the material behaves as a Fermi-liquid metal at low temperatures. Metallic behavior is also confirmed by the $I-V$ characteristics of the STM measurements.
[1] S. Rößler *et al.*, Phys. Rev. B, 82 (2010) 144523.

TT 10.30 Mon 14:00 P4

Thermodynamic, magnetic and transport properties of $Rh_{17}S_{15}$ — •M. Uhlarz[1], O. Ignatchik[1], J. Wosnitza[1,2], A. Haase[1,2,3], M. Doerr[2], R. Daou[3], H. Rosner[3,4], H.R. Naren[5], A. Thamizhavel[5], and S. Ramakrishnan[5] — [1]Hochfeld-Magnetlabor Dresden, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden — [2]Institut für Festkörperphysik, TU Dresden, 01069 Dresden — [3]Max-Planck-Institut für Chemische Physik fester Stoffe, 01187 Dresden — [4]Leibniz-Institut für Festkörper- und Werkstoffforschung, 01069 Dresden — [5]Tata Institute of Fundamental Research, Mumbai-400005, India

We determined thermodynamic (specific heat), magnetic (magnetization, magnetostriction and susceptibility) and transport (electrical resistivity) properties of the 4*d*-electron superconductor $Rh_{17}S_{15}$ ($T_c = 5.3\,\mathrm{K}$). The upper critical field is 19.2 T at $T = 0.07\,\mathrm{K}$. We investigated both a polycrystal and a single crystal. Specific heat gives $\gamma(B=0) = 107\,\mathrm{mJ/\,mol\,K^2}$, $m_{\mathrm{eff}} = 35\,m_0$, and a superconducting energy gap $\Delta_0 = 0.94\,\mathrm{meV}$. The magnetic properties are dominated by flux-line pinning; resistivity likely reveals an amplification of electron-phonon coupling by weak disorder. Additionally, band-structure calculations are presented and interpreted in the context of our own experiments and other recently published results. We interpret our findings in order to find the origin of the strong electronic correlations in $Rh_{17}S_{15}$ both in the superconducting and in the normal-conducting state.

Part of this work has been supported by EuroMagNET II under the EU contract no. 228043.

TT 10.31 Mon 14:00 P4

Coexistence of ferromagnetism and superconductivity in Bi_3Ni nanostructures — •Thomas Herrmannsdörfer[1], Richard Skrotzki[1], Rico Schönemann[1], Joachim Wosnitza[1], Daniel Köhler[2], Regine Boldt[3], and Michael Ruck[2] — [1]Dresden High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), D-01328 Dresden, Germany — [2]Department of Chemistry and Food Chemistry, TU Dresden, D-01062 Dresden, Germany — [3]Leibniz Institute of Polymer Research, D-01069 Dresden, Germany

Materials where superconductivity emerges in an already ferromagnetic orderd phase are explicitly rare. Here we demonstrate that Bi_3Ni nanostructures exhibit a coexistence of superconductivity and ferromagnetism by making use of novel chemical-reaction paths. Via magnetometry and electrical-transport measurements we have characterized their magnetic and superconducting properties. Other than in bulk geometry, submicron-sized particles and quasi one-dimensional nanoscaled strains of single-phase Bi_3Ni undergo ferromagnetic order and still become superconducting at lower temperatures. Furthermore superconductivity is also stable up to remarkably high magnetic fields. Uniquely, ferromagnetic hysteresis at zero resistance is observed in nanostructured Bi_3Ni. An extended study of electronically confined intermetallics may bear the chance to find much more systems which exhibit coexistence phenomena of fundamental ground states of condensed matter.

TT 10.32 Mon 14:00 P4

Enhanced T_c in a Dual-Layered Molecular Superconductor — •Mariano de Souza[1], Leonor Wiehl[2], John A. Schlueter[3], and Michael Lang[1] — [1]Physikalisches Institut, J.W. Goethe-Universität, SFB/TR49, D-60438 Frankfurt (M), Germany — [2]Institut für Geowissenschaften, J.W. Goethe-Universität, D-60438 Frankfurt (M), Germany — [3]Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439, USA

We have revisited the structural and electronic properties of the filamentary organic superconductor $(BEDT\text{-}TTF)_2Ag(CF_3)_4(TCE)$, first synthesized in 1994 [1]. Detailed structural investigations reveal that the BEDT-TTF molecules are arranged in two distinctly different packing motifs, κ and α', which alternate from layer to layer [2]. This molecule-based superconductor with dual BEDT-TTF packing motifs has a T_c five times higher than that of its polymorph that contains only κ-type packing. Using the established empirical correlations between the bond lengths (C–S and C=S) and the oxidation state of the BEDT-TTF molecule, we have found that there is a uniform charge distribution in the κ-layers (corresponding to an oxidation state of +0.5 for all BEDT-TTF molecules), whereas in the α'-layer, half of the molecules are nearly fully oxidized to +1, while the other half are close to neutral, resulting in a charge-ordered neutral layer. These findings indicate that this material can be considered as a promising candidate for a distinctly two-dimensional superconductor.
[1] J. A. Schlueter *et al.*, Physica C **233**, 379 (1994).
[2] J. A. Schlueter *et al.*, J. Am. Chem. Soc. (2010)
doi: 10.1021/ja105854m.

TT 10.33 Mon 14:00 P4

Insights into the phase diagram of high-temperature superconductors obtained by terahertz spectroscopy — •Martin Scheuch[1,2], Luca Perfetti[3], Christian Frischkorn[1,2], Martin Wolf[2], and Tobias Kampfrath[2] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [2]Fritz-Haber-Institut der MPG, Faradayweg 4-6, 14195 Berlin — [3]Laboratoire des Solides Irradiés, Ecole polytechnique, 91128 Palaiseau cedex, France

High resolution data of the electrons scattering rate $\tau^{-1}(\omega, T)$ in the range of 10 to 35 THz and 30 to 320 K measured by THz-transmission spectroscopy on optimally doped and underdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$ samples show the doping dependence of the superconducting gap. In addition a second doping-dependent kink at temperatures above the critical temperature T_c is observed. This feature correlates to the pseudo-gap as its temperature fits to the phase diagram obtained with other techniques.

TT 10.34 Mon 14:00 P4

Two-component behaviour of high-temperature superconductor $HgBa_2CuO_{4+\delta}$ - a ^{199}Hg and ^{63}Cu NMR study — •Damian Rybicki[1], Jürgen Haase[1], Charles Slichter[2], Marc Lux[1], Martin Greven[3], Guichuan Yu[4], and Yuan Li[4] — [1]Faculty of Physics and Earth Science, Leipzig University, Linnéstraße 5, 04103 Leipzig, Germany — [2]Department of Physics, University of Illinois at Urbana-Champaign, Urbana, IL 61801-3080,USA — [3]School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455, USA — [4]Department of Physics, Stanford University Stanford, CA 94305, USA

One of the early, central questions of cuprate high-temperature superconductivity was whether a single-fluid description of the electronic spin susceptibility was appropriate in explaining nuclear magnetic resonance (NMR) experimental data. Recently, it has been shown that in the case of $La_{1.85}Sr_{0.1}CuO_4$ a single fluid picture is inappropriate and two components are necessary. Here, we present the results of ^{199}Hg and ^{63}Cu NMR study of two single crystals of hole doped high-temperature superconductor (HTS), $HgBa_2CuO_{4+\delta}$ an optimally doped and underdoped with T_c=97 K and T_c=74 K, respectively. Careful analysis of the temperature dependence of ^{199}Hg and ^{63}Cu shifts measured for two orientations of the crystal with respect to the external field shows that also in this system, which can be viewed as a model HTS, a single component scenario does not agree with experimental data.

TT 10.35 Mon 14:00 P4

Fluctuation of the hole density of a slightly under-doped (Bi,Pb)$_2$ $Sr_2CaCu_2O_{8+\delta}$ single crystal studied by X-ray absorption spectroscopy — •Ailakbar Ghafari, Ahmad Kamal Ariffin, Robin Weyrich, Christoph Janowitz, Helmut Dwelk, Rüdiger Mitdank, Alica Krapf, and Recardo Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, D-12489 Berlin, Germany

The effects of in-plane polarization change and temperature variation on the determination of the hole density for under-doped (Bi,Pb)-2212 single crystals by XAS have been studied. The XAS signal at the CuL_3 edge (925 eV-940 eV) and O-K edge (525 eV-539 eV) was recorded under continuous rotation of the CuO_2 plane by 180 degree with a minimum increment of 1.8 degree yielding experimentally an in-plane polarization dependence for the absorption signals at the respective thresholds and from that the in-plane angular dependence of the hole density ($n_H(\phi)$). Fermi's golden rule was then used for the evaluation of the in-plane polarization dependence showing unexpected polarization independence. Second, the polarisation geometry was kept fixed and spectra were taken from room temperature to 10 K with a decrement about 10 K. While the polarization dependence $n_H(\phi)$ differed for the respective thresholds the temperature dependence showed less variation. Our results point out to the role of out of plane orbitals which is supported by Anderson and Weber [1, 2].

[1] P. W. Anderson, Science, 235, 1196 (1987)
[2] C. Weber, et al. Phys. Rev. B 82, 125107 (2010)

TT 10.36 Mon 14:00 P4

Temperature dependence of itinerant holes of Bi(Pb)-2212 single crystals in the nearly optimally and under -doped regime by XAS — •Ailakbar Ghafari, Ahmad Kamal Ariffin, Christoph Janowitz, Helmut Dwelk, Rüdiger Mitdank, Alica Krapf, and Recardo Manzke — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, D-12489 Berlin, Germany

We have measured x-ray absorption spectra at the CuL_3 edge for nearly optimum and slightly under-doped single crystals of Bi(Pb)-2212 in a temperature range of 10 K to 300 K. Both fluorescence and total electron yield modes were used. Analysis of the XAS data obtained on the CuL_3 edge yields the change of hole density in the CuO_2 planes with temperature showing a pronounced minimum between 100 K and 200 K. The results are compared to studies on other HTc samples and existing ideas on its origin. Additional the Hall coefficient was determined experimentally by transport measurements at temperatures between 10 K and 300 K. Tentatively an empirical formula to calculate the temperature dependence of the hole density in form of a linear relation with three terms and a second empirical formula of the temperature dependence of the Hall coefficient is not strictly a derivation.

TT 10.37 Mon 14:00 P4

63 Cu and 17 O NMR of electron-doped cuprates — •Michael Jurkutat[1], Grant V. M. Williams[2], Damian Rybicki[1], and Jürgen Haase[1] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, 04103 Leipzig, Germany — [2]The MacDiarmid Institute, Industrial Research, P.O. Box 31310, Lower Hutt 5040, New Zealand

The electron-doped cuprates have scarcely been investigated particularly with nuclear magnetic resonance (NMR), but promise further insight into the still unresolved mechanism of high-temperature superconductivity. We present results of 63 Cu and 17 O NMR of electron-doped $Pr_{2-x}Ce_xCuO_4$ probing the electronic structure locally. Using double resonance methods we were able to separate signals from different sites, which allows a comparison to the electronic structure of hole-doped materials. Interestingly, despite some clear differences our findings suggest the presence of a two-component electronic fluid as is increasingly accepted to be the case in the hole-doped cuprates and associated with their curious normal-state properties.

TT 10.38 Mon 14:00 P4

Optical conductivity of Pr_2CuO_4 in the terahertz range — •T. Fischer[1], A. V. Pronin[1], J. Wosnitza[1], A. Ikeda[2], and M. Naito[2] — [1]Hochfeld-Magnetlabor Dresden (HLD), FZ Dresden-Rossendorf, 01314 Dresden, Germany — [2]Tokyo University of Agriculture and Technology, Tokyo, Japan

Recently, it has been shown that nominally undoped Pr_2CuO_4 can become superconducting, being grown in form of thin films with T' structure [1]. We have measured the temperature and frequency-dependent complex transmission coefficient of these films at terahertz frequencies. From the measured spectra, we have directly calculated the complex optical conductivity. Both components of the conductivity demonstrate a behavior typical for the HTS cuprates. The stiffness of the superconducting condensate is, however, quite low, leading to a large value of the London penetration depth (1.8 μm). We discuss our results in comparison with literature data on terahertz properties of other HTS.

[1] O. Matsumoto, A. Utsuki, A. Tsukada, H. Yamamoto, T. Manabe, and M. Naito, Phys. Rev. B 79, 100508 (2009).

TT 10.39 Mon 14:00 P4

Surface and bulk electronic structure of Sr_2RuO_4 — •Volodymyr Zabolotnyy[1], Emanuela Carleschi[2], Timur Kim[1], Alexander Kordyuk[1], Jan Thöne[1], Johen Geck[1], Daniil Evtushinsky[1], Bryan Doyle[2], Rosalba Fittipaldi[3], Mario Cuoco[3], Antonio Vecchione[3], Bernd Büchner[1], and Sergey Borisenko[1] — [1]IFW - Dresden, Germany — [2]University of Johannesburg, South Africa — [3]CNR-INFM SuperMat Regional Laboratory, University of Salerno, Italy

Strontium ruthenates are famous for p-type superconductivity, metamagnetism, and notable spin-orbit coupling. Understanding all these phenomena requires a detailed knowledge of the electronic structure. Unfortunately recent ARPES on Sr_2RuO_4 was confronted with a problem of an acute 'surface state' (SS). Here we argue that, instead of the earlier proposed remedy of high temperature cleaving, one may rely on excitation energy dependence of matrix elements enhancing surface or bulk features, while circularly polarized light can be used to establish their origin. Owing to the minimized surface degradation we observe bulk α, β, γ bands and their surface counterparts along with additional δ feature. According to the dichroic pattern the new feature must be yet another surface counterpart of the β band. Also the narrower momentum width together with negligible k_z dispersion are distinct properties specific to a surface state. Since there are numerous examples where the surface state undergoes splitting due to spin-orbit interaction we suggest that full relativistic calculation might be needed to understand the origin of the new feature.

TT 10.40 Mon 14:00 P4

Nonlinear transport near the superconductor/insulator transition in thin TiN films — •D Kalok[1], A. Bilušić[1,2], T.I. Baturina[3,4], I. Schneider[1], V.M. Vinokur[4], and C. Strunk[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, Germany — [2]Department of Physics, Faculty of Science, University of Split, Croatia — [3]Institute of Semiconductor Physics, Novosibirsk, Russia — [4]Materials Science Division, Argonne National Laboratory, Argonne, Illinois, USA

We investigate experimentally the electric transport at the insulating side of the superconductor to insulator transition in thin TiN-films. At temperatures $T > 50$ mK we observe an Arrhenius-type conductance, with an activation energy depending logarithmically on the sample size. At high bias the current voltage (I-V) characteristics display a large current jump into an electron heating dominated regime. For the largest samples, and below 50 mK we observe a low-bias power law $I \propto V^\alpha$ characteristics with an exponent $\alpha > 1$ rapidly growing with decreasing temperature, which is expected for a binding-unbinding crossover of the charge-Berezinskii-Kosterlitz-Thouless type.

TT 10.41 Mon 14:00 P4

Discontinuity of capacitance at the onset of surface superconductivity controlled by electric fields — •Klaus Morawetz[1,2], Pavel Lipavský[3,4], and Jan Kolaček[4] — [1]University of Applied Science Münster, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — [2]International Institute of Physics (IIP), Universidade Federal do Rio grande do Norte - UFRN, Brazil — [3]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic — [4]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic

The effect of the electrostatic field is discussed on superconductivity near the surface exposed to magnetic fields. The Ginzburg-Landau equation is solved near the surface and the surface energy is calculated. The nucleation critical field is shown to be changed in dependence on the magnetic and electric field. The surface energy becomes strongly dependent on the width of the sample. We predict that the field effect on the surface superconductivity leads to a discontinuity of the magnetocapacitance. We estimate that the predicted discontinuity is accessible for nowadays experimental tools and materials. It is shown that the magnitude of this discontinuity can be used to predict the

dependence of the critical temperature on the charge carrier density which can be tailored by doping.

[Phys. Rev. B 78 (2008) 054525; New J. Phys. 11 (2009) 023032-1-8; Lecture notes in Physics 733, Springer Verlag Berlin (2007); Springer Series NanoScience and Technology, Springer (2010)]

TT 10.42 Mon 14:00 P4

Static and dynamic properties of Abrikosov vortices in Nb thin films with superconducting pillar landscapes — •Benedikt Betz, Daniel Bothner, Matthias Kemmler, Markus Turad, Reinhold Kleiner, and Dieter Koelle — Physikalisches Institut and Center for Collective Quantum Phenomena, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany

The static and dynamic properties of Abrikosov vortices in artificially patterned potential landscapes were subject to many experimental and theoretical investigations since the 1960s. Up to now the potential landscapes were in most cases generated by a well-defined distribution of local potential minima, so called pinning sites, for Abrikosov vortices. In this work, we experimentally investigate the properties of vortices in potential landscapes, which are generated by a lattice of superconducting Nb pillars on the top of Nb thin films, used as highly controllable local anti-pinning centers, see [1]. The structures were fabricated by a combination of lithography and reactive ion etching. We produced several sets with variations in the pillar lattice constant, in the height of the pillars with respect to the film thickness and in the radius of the pillars from one half to a fifth of the lattice constant. By measuring I-V-characteristics for different values of temperature T and applied magnetic field B, we investigate the vortex-pillar interaction with respect to static commensurability effects. The superposition of dc and ac driving currents allows for the investigation of possible phase locking of the vortex motion to the ac drive.

[1] G.R. Berdiyorov *etal.*, Phys. Rev. B **77**, 024526 (2008)

TT 10.43 Mon 14:00 P4

Vortex imaging in YBCO grain boundary junction SQUIDs using low-temperature scanning electron microscopy — •Matthias Bailer, Christian Gürlich, Matthias Kemmler, Reinhold Kleiner, and Dieter Koelle — Physikalisches Institut - Experimentalphysik II and Center for Collective Quantum Phenomena, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

We used low-temperature scanning electron microscopy (LTSEM)[1] for imaging of Abrikosov vortices in $YBa_2Cu_3O_7$ (YBCO) washer dc SQUIDs at 77 K, with a spatial resolution of about 1 μm. This imaging technique is based on the electron-beam-induced apparent displacement of vortices, which is detected as a flux change in the SQUID [2]. Vortex images obtained by LTSEM allow e.g. to estimate the distribution of pinning energies in YBCO films, or to image the sheet-current distribution in SQUID washers [3].

We report on recent progress in imaging of single vortices. Using new SQUID designs with bicrystal grain boundary junctions optimized for imaging and detection of the flux noise of a single vortex trapped in the SQUID washer, the investigation of single vortex properties by LTSEM will be presented.

[1] R. Gross and D. Koelle, Rep. Prog. Phys. 57, 651-741 (1994).
[2] D. Doenitz et al., Appl. Phys. Lett. 85, 5938-5940 (2004).
[3] D. Doenitz et al., Phys. Rev. B 73, 064508 (2006).

TT 10.44 Mon 14:00 P4

Vortex motion in granular MgB_2 thin films - Investigations with magneto-optical imaging — •Claudia Stahl[1], Sebastian Treiber[1], and Joachim Albrecht[2] — [1]Max-Planck-Institut für Metallforschung, Stuttgart, Germany — [2]Hochschule Aalen, Germany

In magnesium diboride (MgB_2) thin films there are different kinds of vortex motion. Flux flow and thermally activated flux creep form the current carrying state in an external magnetic field. At lower temperatures dynamically driven flux avalanches containing areas of vanishing supercurrents occur. Flux penetration as well as the critical current density can be determined locally and quantitatively via magneto-optical imaging based on the Faraday effect.

We use this method to measure properties of MgB_2 films with different granularity. In a particular production process we achieved to create areas of varying granularity on an individual substrate. This allows a direct analysis of the consequences of granularity.

It is shown that in granular films the dendritic state as well as the regular critical state both are modified: we find a reduced critical current density j_c, which decreases rapidly with increasing temperature. Additionally magnetic avalanches are favoured in the granular area, whereas generally they are triggered by high current densities. This requires a more detailed understanding of formation and propagation of magnetic avalanches in inhomogeneous media [1].

[1] S. Treiber and J. Albrecht, *New Journal of Physics* **12**, 093043 (2010).

TT 10.45 Mon 14:00 P4

Tunable double well potential for fractional Josephson two-vortex molecule — •Dennis M. Heim[1], Karl Vogel[1], Wolfgang P. Schleich[1], Edward Goldobin[2], Dieter Koelle[2], and Reinhold Kleiner[2] — [1]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Physikalisches Institut and Center for Collective Quantum Phenomena, Universität Tübingen, D-72076 Tübingen, Germany

We study a fractional Josephson two-vortex molecule in a long Josephson 0-κ-2κ junction. The ground state is degenerate, corresponding to two configurations with topological charges $(\kappa, \kappa-2\pi)$ and $(\kappa-2\pi, \kappa)$ of fractional vortices. We propose to use such a system to study macroscopic quantum phenomena involving fractional vortices. Similar to the previous proposal based on a 0-π-0 junction [1], the two-vortex-molecule states can be mapped to a double well potential. However, by changing the value of κ during experiment we are able to tune the energy barrier separating the two classical ground states. We calculate characteristic properties (e.g. barrier height, eigenfrequency) and demonstrate that a controlled transition into the quantum regime is possible in such a system.

[1] E. Goldobin et al., Phys. Rev. B **72**, 054527 (2005).

TT 10.46 Mon 14:00 P4

Anomalous features in $I_c(H)$-patterns of multifacet Josephson junctions — •Sebastian Scharinger[1], Christian Gürlich[1], Roman G. Mints[2], Martin Weides[3], Hermann Kohlstedt[4], Edward Goldobin[1], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Physikalisches Institut-Experimentalphysik II and Center for Collective Quantum Phenomena, Universität Tübingen, Germany — [2]The Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Israel — [3]National Institute of Standards and Technology, Boulder, Colorado, USA — [4]Nanoelektronik, Technische Fakultät, Christian-Albrechts-Universität zu Kiel, Germany

Multifacet Josephson junctions (MJJs) with alternating 0 and π facets have been intensively investigated within the last years. The experimental dependence of their critical current on applied magnetic field $I_c(H)$ so far notoriously deviated from theoretical prediction. We have realized MJJs using superconductor-insulator-ferromagnet-superconductor heterostructures where 0 and π regions alternate 40 times. Here we show that anomalous features of $I_c(H)$ are caused by a non-uniform flux density parallel to the barrier resulting from screening currents in the electrodes in the presence of a (parasitic) off-plane field component. Further, we demonstrate that there is a specific "dead angle", which may be very close to in-plane field orientation. If the field applied by chance at the dead angle or close to it, the average flux density vanishes, resulting in very anomalous $I_c(H)$. This may lead to erroneous conclusions about the sample quality or even the physics investigated. This effect can also be observed in conventional junctions.

TT 10.47 Mon 14:00 P4

Triplet-superconductor-ferromagnet-triplet-superconductor junctions: Effects of finite width — •Bogusz Bujnowski, P.M.R. Brydon, and Carsten Timm — Institut für Theoretische Physik, Technische Universität Dresden, Germany

We study charge and spin transport in a junction involving triplet superconductors and ferromagnets. We analyze this system by using the Bogoliubov-de Gennes wavefunctions to construct the Green's function, from which we can obtain formulas for the Josephson currents in terms of the Andreev reflection coefficients. We investigate the occurrence of the 0-pi transition for a magnetic tunneling barrier of finite width, and examine the appropriateness of the usual delta-function approximation for the tunneling region.

TT 10.48 Mon 14:00 P4

Spin transport in diffusive ferromagnetic Josephson junctions with noncollinear magnetization — •Zahra Shomali[1], Malek Zareyan[1], and Wolfgang Belzig[2] — [1]Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan 45195, Iran — [2]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany

We numerically study the Josephson coupling of two s-wave superconductors which are connected through a diffusive contact made of two ferromagnetic domains with the magnetization vectors misoriented by an angle θ. The assumed superconducting leads are conventional s-wave type with the phase difference of φ. Using the quantum circuit theory, we find that in addition to the charge supercurrent, which shows a $0-\pi$ transition relative to the angle θ, the spin supercurrent with a spin polarization normal to the magnetization vectors will flow through the contact. Our results present a 0-π quantum phase transition as a function of the wave vector, $Q\xi$. Finally, we investigate the spin supercurrent in an extended magnetic texture with multiple domainwalls. We find the behavior of spin supercurrent is highly sensitive to the barrier. When asymmetric barriers don't change the value of the spin supercurrent, the symmetric ones decrease the value of it notably. We also investigate some other interesting effects for these systems. In addition, we present when $Q\xi$ is the even multiple of π, the spin-current which is penetrated into the nonhomogeneous ferromagnets is nearly zero, how ever the odd ones show the large amount of penetrated spin supercurrent.

TT 10.49 Mon 14:00 P4

Charge transport through 1D arrays of small capacitance Josephson junctions with uniform voltage bias — •Jochen Zimmer[1], Roland Schäfer[2], Hannes Rotzinger[1], and Alexey V. Ustinov[1] — [1]Physikalisches Institut, Karlsruhe Institut of Technology — [2]Institut für Festkörperphysik, Karlsruhe Institut of Technology

We investigate one-dimensional arrays of small capacitance Josephson junctions fabricated by conventional e-beam lithography techniques. The arrays are designed to operate in the vicinity of the Coulomb blockade regime. It has been suggested that charges propagate though these arrays in a form similar to solitary waves, described by the sine-Gordon model. This system is dual to a long Josephson junction, in which magnetic flux solitons have been thoroughly investigated in the past. Localized charge excitations could be of metrological interest because they might offer access to very accurate frequency-to-current conversion (I = 2e f). In conventional setups, the bias voltage is only applied to the edges of the array, decaying exponentially from junction to junction. In order to achieve uniform force on charge carriers in the array, the voltage drop from junction to junction must be uniform. We present fabricated arrays with a uniform biasing scheme and first measurements thereof. We also show measurement results of similar arrays under rf radiation obtained at millikelvin temperatures.

TT 10.50 Mon 14:00 P4

Dynamical Coulomb blockade of nonlocal conductance in N/S hybrid structures — •Michael J. Wolf[1], Florian Hübler[1,2], Detlef Beckmann[1], and Hilbert v. Löhneysen[2,3] — [1]Institut für Nanotechnologie, KIT, 76021 Karlsruhe, Germany — [2]Institut für Festkörperphysik, KIT, 76021 Karlsruhe, Germany — [3]Physikalisches Institut, KIT, 76021 Karlsruhe, Germany

In multi-terminal N/S hybrid structures, crossed Andreev reflection and elastic cotunneling give rise to non-zero nonlocal conductance as it was investigated both experimentally and theoretically ([1], [2] and references therein).

We fabricated multi-terminal N/S hybrid structures by standard e-beam lithography and shadow evaporation techniques in order to gain further understanding of the nonlocal signal. The distance between the two contacts was chosen to be approximately 150 nm and care was taken to eliminate Josephson effects. Measurements were taken in a 4-probe setup using lock-in technique.

If non-zero bias voltages V_A and V_B are applied to both contacts, we observe a S-shaped nonlocal differential conductance dI_B/dV_A when sweeping V_A. These findings are consistent with recently published calculations on the influence of Coulomb effects on the nonlocal conductance in N/S hybrid structures [2].

[1] J. Brauer et al., Phys. Rev. B **81**, 024515 (2010)
[2] D.S. Golubev and A.D. Zaikin, Phys. Rev. B **82**, 134508 (2010)

TT 10.51 Mon 14:00 P4

Quantum phase slip dynamics in Josephson junction chains — •Thomas Weissl[1], Iulian Matei[1], Ioan Mihai Pop[1], Florent Lecocq[1], Christoph Schenke[2], Gianluca Restelli[2], Frank W. Hekking[2], Olivier Buisson[1], and Wiebke Guichard[1] — [1]Institut Néel, CNRS/Université Joseph Fourier, Grenoble, France — [2]LPMMC, CNRS/Université Joseph Fourier, Grenoble, France

In contrast to Josephson Junctions (JJ) which show a tunneling of superconducting charge carriers, phase-slip junctions are characterized by a tunneling of the superconducting phase. It has been shown theoretically[1] that phase-slip junctions can be realized by including a JJ in a high impedance environment or by using a long chain of JJ's. Phase-slip junctions could have an important metrological application, as under microwave irradiation they are expected to show plateaus of constant current at multiples of the applied microwave frequency. This frequency to current conversion could be used to implement a current standard. We present measurements of the current voltage characteristics of JJ chains of different lengths. For shorter chains we observe a zero current state that we attribute to quantum phase-slip dynamics[2] in the chain. A superconducting like behavior is observed for longer chain that we understand by taking into account the excitation of standing electromagnetic waves in the chain.

[1] W.Guichard and F.W. Hekking Phys. Rev. B 81, 064508 (2010)
[2] I. Pop et al Nature Physics 6, 589-592 (2010)

TT 10.52 Mon 14:00 P4

Application of NbSi nanowires for quantum phase slip experiment — •Terhi T. Hongisto and Alexander B. Zorin — Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

A superconducting nanowire of sufficiently small (nanometer scale) cross section is expected to lose phase coherence due to the quantum phase slips (QPS) at low temperatures. The QPS nanowire combined with high impedance environment forms a system dual to the Josephson junction and is suggested to be applicable for a quantum current standard [1]. In analogy to the current-biased Josephson junction this QPS nanowire, biased by voltage below the critical value V_C, can be characterized by a washboard potential for the charge variable. Application of ac drive should result in the steps of current, $I = 2ef$, which are dual to Shapiro steps.

Using approach similar to ones described in [2, 3] we have developed technology of fabrication of NbSi nanowires with cross sections down to 15 nm by 8 nm integrated with high-ohmic Cr film resistors. The circuits have been characterized at mK temperatures and some of them exhibited characteristic Coulomb blockade behaviour.

[1] J. E. Mooij, Yu. V. Nazarov, Nature Phys. 2, 169 (2006).
[2] J. Romijn, PhD Thesis, Delft University, (1991).
[3] T. van der Sar, Master Thesis, Delft University, (2007).

TT 10.53 Mon 14:00 P4

Raman light scattering on $YBa_2Cu_3O_7/La_{2/3}Ca_{1/3}MnO_3$ Superlattices — •Nadir Omar Driza, Mohammed Bakr, Santiago Blanco Canosa, Soltan Soltan, Hanns-Ulrich Habermeier, Giniyat Khaliullin, Mathieu Le Tacon, and Bernhard Keimer — Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany

Artificial superlattice (SL) structures offer a possibility of combining antagonistic order parameters such as superconductivity (SC) and ferromagnetism (FM). It was recently observed [1] that the interface between $YBa_2Cu_3O_7$ (YBCO) and $La_{2/3}Ca_{1/3}MnO_3$ (LCMO) exhibits an unusual orbital reconstruction different than that of either YBCO or LCMO. Therefore, it is of fundamental interest to explore proximity and inverse-proximity effects that take place at the vicinity of the interface between the two systems using Raman scattering (RS). We have performed RS experiments on YBCO/LCMO SLs with different thicknesses of YBCO, i.e., 5-50 nm and constant thickness of LCMO (10 nm). We focus our study on the 230 cm^{-1} phonon, which arises from in-phase rotations of the MnO_6 octahedra and the 340 cm^{-1} mode originating from out-of-phase vibrations of the oxygen atoms in the CuO_2 planes of YBCO. Our T-dependence measurements revealed a strong anomaly in the phonon frequency and linewidth of these modes at the SC- and Curie transition temperatures. The anomaly we observe appears to be tied to a competition between electronic instabilities at the YBCO/LCMO interfaces and the bulk electronic properties of both layers.

[1] J. Chakhalian *et al.*, Nature Phy. **2**, 244 (2006).

TT 10.54 Mon 14:00 P4

FFLO like State in Bilayers and Trilayers of Superconductors and Ferromagnets: The Spin-Valve Core Structure — •Vladimir Zdravkov[1,2], Jan Kehrle[1], Günter Obermeier[1], Aladin Ulrich[1], Claus Müller[1], Roman Morari[2], Anatolie Sidorenko[2], Lenar Tagirov[3], Reinhard Tidecks[1], and Siegfried Horn[1] — [1]Institut für Physik, Universität Augsburg, D-86159 Augsburg, Germany — [2]Institute of Electronic Engineering and Nanotechnologies ASM, MD 2028 Kishiniev, Moldova — [3]Solid State Physics

Department, Kazan State University, 420008 Kazan, Russia

Critical temperature oscillations and reentrant superconductivity has been observed in thin film bilayers and trilayers made of Nb as superconducting (S) and $Cu_{41}Ni_{59}$ as ferromagnetic (F) metal, for increasing F-layer thickness. This effect is caused by the establishing of the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) like state in these geometries, leading to interference effects of the superconducting pairing wave function. While in our former investigations S/F bilayers were investigated [1], we here report on F/S bilayers where the S-metal now is grown on top of the F-metal, and the combination of both building blocks to a F/S/F trilayer, i.e. the core structure of the superconducting spin valve [2].

[1] V. I. Zdravkov, J. Kehrle, G. Obermeier, et al. Phys. Rev. B 82, 054517 (2010)

[2] L. R. Tagirov, Phys. Rev. Lett. 83, 2058 (1999)

TT 10.55 Mon 14:00 P4

Spin-dependent boundary conditions for diffusive quasiclassical Green's functions at weakly polarised tunnel interfaces — •Peter Machon[1], Matthias Eschrig[1,2], and Wolfgang Belzig[1] — [1]Department of Physics, University of Konstanz, D-78457 Konstanz, Germany — [2]Department of Physics, Royal Holloway, University of London, Egham Hill, EGHAM, TW20 0EX, UK

The quasiclassical Green's function method is a standard tool to describe the transport properties of diffusive superconducting heterostructures. Since this approach is not suited for heterostructures containing ferromagnets it has to be supplemented by spin-dependent boundary conditions [1]. Here we present a correction to the boundary conditions [1] for the case of weakly polarized tunnel interfaces. The resulting matrix current is described by a few parameters containing the spin-dependent interfacial phase shifts. We apply the new boundary conditions to a three terminal proximity system using a finite-element approach to study the influence of these parameters on the conductivities. Our setup consists of two ferromagnetic and a superconducting terminal coupled via tunneling barriers. We analyze the local and nonlocal spin-dependent currents and determine various ways to tune the resulting conductivities using the spin-dependent interface parameters.

[1] A. Cottet et al., Phys. Rev. B 80, 184511 (2009)

TT 10.56 Mon 14:00 P4

Hybrid Rings for circuit Quantum Electrodynamics — •E. Hoffmann[1], F. Deppe[1], T. Niemczyk[1], T. Wirth[2], E. P. Menzel[1], G. Wild[1], H. Huebl[1], F. Bilger[1], M. Mariantoni[1], A. Lukashenko[2], A. P. Zhuravel[3], A. Ustinov[2], A. Marx[1], and R. Gross[1] — [1]Walther-Meissner-Institut and TU München, Garching, Germany — [2]Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany — [3]B. I. Verkin Institute for Low Temperature Physics and Engineering, Kharkov, Ukraine

During the last years, superconducting circuit quantum electrodynamics (circuit QED) has attracted increasing interest. Experiments in this field require detection schemes for microwave signals on the single photon level. In particular, devices acting as microwave beam splitters are necessary. Using niobium thin films on silicon and sapphire substrates, we fabricated superconducting 180° microstrip hybrid ring couplers, acting as beam splitters with center frequencies of about 6 GHz. For the magnitude of the coupling and isolation we find -3.5 ± 0.5 dB and at least -15 dB, respectively, in a bandwidth of 2 GHz. We also investigate the effect of reflections at the contact between the superconducting hybrid ring and the normal conducting wiring using low temperature laser scanning microscopy. Our measurements indicates that our hybrid rings are well suited for on-chip applications in circuit quantum electrodynamics experiments.

We acknowledge financial support by the DFG via SFB 631, as well as support by and CFN, EU project SOLID and the German Excellence Initiative via NIM.

TT 10.57 Mon 14:00 P4

Spatially-Resolved Single-Photon Detection in NbN Nanowires — •Philipp Jung[1], Alexander Lukashenko[1], Alexander P. Zhuravel[4], Stefan Wuensch[2,3], Matthias Hofherr[2], Konstantin Ilin[2], Michael Siegel[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, Karlsruhe, Germany — [2]Institut für Mikro- und Nanoelektronische Systeme, Karlsruher Institut für Technologie, Karlsruhe, Germany — [3]Supported by the DFG-Center for Functional Nanostructures — [4]B. Verkin Institute for Low Temperature Physics & Engineering, Kharkov, Ukraine

We are investigating the mechanism of the single photon photoresponse in superconducting nanowires patterned from NbN thin-films on sapphire substrate. Current-biased close to their critical current, these nanowires are sensitive to small disturbances such as the absorption of a photon and are therefore used as single-photon detectors.

Although previous experiments on straight wires have shown their local critical currents to be quite inhomogeneous due to the existence of grain boundaries, meander shaped nanowire detectors exhibit a comparatively homogeneous spatial pattern of photon detection efficiency. To gain a deeper understanding of the relation between the local photon detection efficiency and the local critical current we are going to present comparative measurements of these two quantities acquired using a low temperature laser scanning microscope as well as a comparison of our results with existing theoretical predictions.