TT 1 Superconductivity - Fabrication, Technical Optimization and Characterization

Zeit: Freitag 10:15–13:00 Raum: TU H104

TT 1.1 Fr 10:15 TU H104

Boron-doped Diamond Films — •H.C. Freyhardt[1], K. Winzer[2], D. Bogdanov[2], P.J. Wilbrandt[1], M. Malchow[1], L. Schäfer[3], and J. Wurm[4] — [1]Institut für Materialphysik und — [2]1. Physikalisches Institut der Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [3]Fraunhofer-Institut Schicht u. Oberflächentechnik, Bienroder Weg 54E, 38108 Braunschweig — [4]METAKEM GmbH, Achtzehnmorgenweg 3, 61250 Usingen

After superconductivity was reported in bulk high-pressure synthesized B containing diamond, B-doped diamond films were deposited on polycrystalline W and single-crystalline Si substrates by a hot-filament activated chemical vapour deposition process. The polycrystalline films exhibit lattice constants which are slightly larger than for pure diamond. Whereas films on W are under compressive stresses, films on Si are almost stress-free. The nominal B-concentration varied between 2700 and 5200 ppmB and was checked by SIMS and Raman spectroscopy. Superconductivity was observed in all samples with a transition temperature T_c up to 3.3K for 5200 ppmB. The T_c increases with the B content and the transition width was found to be 0.2K for the best sample. Upper critical fields $B_{C2}(0)$ are scaling with T_c and reach 3.6T. It will be discussed whether superconductivity can be described by a BCS-like behaviour.

TT 1.2 Fr 10:30 TU H104

Superconductivity on boron-doped diamond plates — •Dmitrij Bogdanov[1], Klaus Winzer[1], and Christoph Wild[2] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Fraunhofer Institut für Angewandte Festkörperphysik, Tullastr. 72, 79018 Freiburg i. Br.

We study boron-doped diamond plates prepared by the microwave-plasma-CVD technique. In contrast to diamond films on silicon substrates the absence of a substrate allows unequivocal measurements of the electrical resistivity and of the Hall coefficient of the doped diamond. The samples show semiconducting behaviour in the non-superconducting state down to the critical temperatures between 0,4 K $< T_C <$ 4 K. The upper critical fields $B_{C2}(0)$ scale with the transition temperatures T_C; their values are up to 3 tesla. The hole concentrations were determined by the measurements of the Hall coefficient at temperatures near T_C. The correlation of the calculated density of states $N(E_F)$ and T_C will be compared with different theoretical models.

TT 1.3 Fr 10:45 TU H104

Superconductivity in nominally undoped La based T′-structure cuprates — •Yoshiharu Krockenberger[1,2], Akio Tsukada[1], Hideki Yamamoto[1], Dirk Manske[2], Michio Naito[3], and Lambert Alff[4] — [1]NTT Basic Research Laboratories, 3-1 Morinosato-Wakamiya,Atsugi, Kanagawa 243-0198, Japan — [2]Max-Planck-Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany — [3]Department of Applied Physics, Tokyo University of Agriculture and Technology, 2-24-16 Naka-cho, Koganei, Tokyo 184-8588, Japan — [4]Vienna University of Technology, ISAS, Applied Electronic Materials, Gusshausstr. 27-29/366,A-1040 Vienna, Austria

La_2CuO_4 in the T-structure is classified as the Mott-insulating "parent compound"of the high-temperature supeconductors. However, La_2CuO_4 with Nd_2CuO_4 (T′) structure has not yet been synthesized and investigated due to the ionic size driven structural instability to the T-phase. We report the synthesis of $La_{2-x}RE_xCuO_4$ with the T′ structure by molecular beam epitaxy, using isovalent substituents RE = Sm, Eu, Gd, Tb, Lu, and Y for La stabilizing the T′ phase. Surprisingly, all these nominally undoped T′-compounds show metallic behavior and even become superconducting at critical temperatures up to 25 K. The observed smooth decrease of the resistivity of samples grown in increasingly reducing atmosphere suggests that for these materials the expected Mott-insulating state is not obtained even close to the undoped compound. The phase diagram of the electron-doped T′-compounds therefore seems to depend strongly on details of the crystal structure.

TT 1.4 Fr 11:00 TU H104

Preparation and characterization of UPd_2Al_3 thin films in (100) orientation — •Michael Foerster, Christian Herbort, Martin Jourdan, and Hermann Adrian — J.-Gutenberg-Universität Mainz

We prepared for the first time high quality thin films of the Heavy-Fermion superconductor UPd_2Al_3 in a*-axis orientation employing MBE methods. The natural (001) growth direction can be changed to (100) by using $YAlO_3$ (010) and (112) substrates. The samples were characterized in respect of their crystalline and superconducting properties. Buffer layers of naturally a*-axis oriented UNi_2Al_3 with thickness $\approx$ 100Å resulted in clearly improved film quality. These new samples enable tunneling experiments on UPd_2Al_3 in a*-axis direction, which are of high interest to further investigate the symmetry of the unconventional sc-order parameter in this model system for Heavy-Fermion superconductivity.

TT 1.5 Fr 11:15 TU H104

Density of critical current of Nb and NbN thin film bridges — •Konstantin Ilin[1], Michael Siegel[1], Alexei Semenov[2], Heinz-Wilhelm Hübers[2], and Andreas Engel[3] — [1]Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, Karlsruhe, Germany — [2]DLR Institut für Planetenforschung, Berlin, Germany — [3]Physics-Institute of the University of Zürich, Zürich, Switzerland

We present results of a systematic study of the critical current in superconducting Nb and NbN thin film bridges. The bridges with a width from 50 nm to 10μm were patterned from thin superconducting films by means of electron-beam lithography and ion milling. For both materials the nominal critical current density extrapolated to zero temperature varied with the bridge width and thickness. We attribute these variations to a fabrication-enhanced reduction of the effective, superconducting cross-section of the bridges with respect to their geometric cross-section and to an uneven distribution of the super-current over the superconducting core of the bridge. In very thin bridges, i.e. 5 nm and 8 nm for NbN and Nb, respectively, the nominal current density increased drastically when the bridge width became smaller than 500 nm. We associate the enhancement of the critical current in those bridges with the crossover from depinning of magnetic vortices to either their nucleation or breaking of Cooper pairs.

TT 1.6 Fr 11:30 TU H104

Laserablation und Charakterisierung von MgB_2 Filmen — •Christian Leirer, Andreas Heinrich und Bernd Stritzker — Universität Augsburg, EPIV, 86135 Augsburg

Seit der Entdeckung der Supraleitung in MgB_2 wurden unterschiedliche Verfahren zu dessen Herstellung entwickelt. Bei der Herstellung dünner Filme spielte die Laserablation bisher eine untergeordnete Rolle, da die erhaltenen Schichten deutlich schlechtere supraleitende Eigenschaften gegenüber dem Bulk-Material aufwiesen. Wir wollen hier eine modifizierte Methode der Lasseablation vorstellen, mit der es uns möglich ist, eine Sprungtemperatur von 38,5 K zu erreichen, was nahezu dem Wert des Bulk-Materials entspricht. Dies gelingt mit einem besonderen in-situ Annealingverfahren. Die erzielten Sprungtemperaturen liegen deutlich über den bisher mit PLD erreichten Werten. Zudem gelang es uns durch teilweise Abschattung des Substrates gegenüber dem Plasma, in diesem Bereich ein verbessertes Schichtwachstum zu erhalten. Das in-situ Annealingverfahren wird vorgestellt und die Mechanismen des Abschattungseffektes werden diskutiert. Weiter berichten wir über die Korrelation zwischen Plasmaeigenschaften während der Ablation, strukturellen sowie magnetfeldabhängigen supraleitenden Eigenschaften.

TT 1.7 Fr 11:45 TU H104

Superconductivity in nanocrystalline mechanically alloyed MgB_2 bulk samples and Fe sheathed multifilamentary tapes — •Olaf Perner[1], Wolfgang Hässler[1], Claus Fischer[1], Marko Herrmann[1], Günter Fuchs[1], Konstantin Nenkov[1], Bernhard Holzapfel[1], Ludwig Schultz[1], and Jürgen Eckert[2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, PF 270116, D-01171 Dresden — [2]TU Darmstadt, Petersenstr. 23, D-64287 Darmstadt

The application of the mechanical alloying (MA) technique for MgB_2 powder preparation can be regarded as an optimal tool to obtain a nanocrystalline microstructure due to grain refinement as well as to control the exact stoichiometry of the MgB_2 compound. Subsequently hot pressed bulk samples as well as by the powder-in-tube technique fabricated tapes show enhanced magnetic flux pinning in the superconducting state resulting in high critical current density J_c values.

In order to investigate the role of grain boundaries and impurities on superconductivity in MgB_2 a series of bulk samples with different preparation parameters as well as impurity doping with oxides were characterized by transport and magnetization measurements as well as analytical transmission electron microscopy. The results will be described in detail and compared with the model of vortex dynamics.

The multifilamentary MgB_2 tapes exhibit high values of the critical current density J_c of 35 kA/cm^2 and 9 kA/cm^2 in external magnetic fields of 7.5 T and 10 T, respectively, at 4.2 K due to a homogeneous, nanocrystalline microstructure and small sized impurities.

TT 1.8 Fr 12:00 TU H104

In-situ RHEED-Charakterisierung und elektrische Eigenschaften von $YBa_2Cu_3O_7$-Schichten — •A. Hirsch, M. Karger, F. Ludwig und M. Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU-Braunschweig, Hans-Sommer-Str. 66, D-38106 Braunschweig

Zur Herstellung von Bauelementen aus Hochtemperatursupraleitern wie Josephson-Kontakte und supraleitende Quanteninterferometer (SQUIDs) sind dünne Schichten hoher epitaktischer Qualität erforderlich.

Mit den Methoden der statistischen Versuchsplanung wird das Wachstum von $YBa_2Cu_3O_7$ auf $SrTiO_3$-Einkristallsubstraten mittels gepulster Laser-Deposition (PLD) in Hinblick auf die strukturellen und elektrischen Eigenschaften untersucht. Insbesondere wird ein Zusammenhang zwischen den aus in-situ RHEED-Untersuchungen gewonnenen epitaktischen Eigenschaften der Schichten und den elektrischen Eigenschaften Übergangstemperatur T_c, kritische Stromdichte j_c bei 77 K und relativen Widerstandsverhältnis R(300 K)/R(100 K) geprüft. Desweiteren wird der Einfluss von kontinuierlicher bzw. Intervall-Deposition auf die Schichtqualität diskutiert. Ein Überblick über die Ergebnisse wird gegeben.

TT 1.9 Fr 12:15 TU H104

J_c enhancement in $YBa_2Cu_3O_{7-x}$ thin films by metal doping — •J. Hänisch, C. Cai, R. Hühne, B. Holzapfel und L. Schultz — IFW Dresden, Helmholtzstraße 20, 01069 Dresden

Due to the sharp cube textures in RABiTS (rolling assisted biaxially textured substrates) tapes, grain boundaries are not the only J_c limiting factor anymore and flux pinning is now again a focus for further improvement of coated conductors in higher magnetic fields.
In this work, we present a comparative study of the influence of different metallic dopants (D: Ir, Ti, Zr and Hf) on $J_c(B)$. Quasi-multilayer films of 40x(6.5 uc YBCO/n uc D) were prepared by pulsed laser deposition with a stoichiometric YBCO target and a metal target for the dopant, n being in the range of 0.04...0.3. In the case of Ir, nano-particles of $BaIrO_3$ are growing epitaxially inside the YBCO film. Due to their larger lattice parameter of 4.1 Å compared to 3.9 Å (b-axis) in YBCO, the YBCO structure is under lateral stress. A certain degree of disorder on the Ba sites is expected because of the non-stoichiometry after precipitation. Both introduce extended and random defects respectively and lead to an enhancement in pinning force density and irreversibility field.
In addition, Zn doping is investigated as a possibility to enhance J_c in thin films. At doping levels of x $< 0.05\%$, an increase in J_c in higher magnetic fields was found.

TT 1.10 Fr 12:30 TU H104

Cube textured Cu-based substrates for HTS coated conductors — •Rainer Nast, Bernhard Obst, Gunter Kotzyba, and Wilfried Goldacker — Forschungszentrum Karlsruhe, Institut für Technische Physik, Postfach 3640, 76021 Karlsruhe

As alternative substrate tapes for coated conductor, cube textured copper based tapes instead of nickel are possible candidates to achieve high critical current densities in YBCO. The advantages of Cu are the non-ferromagnetism, the larger thermal and electrical conductivity and the lower cost of Cu in comparison to Ni. In this work, we report about the texturing of pure copper and different copper alloys, such as Cu-Sn, Cu-Mn and a dispersion hardened Cu-B4C tape. The annealing temperature have been optimized to get a high volume fraction of the cube texture as sharp as possible. The maximum of the cube texture deviation histograms is at 3.8° for Cu and 4.4° for Cu-B4C. In addition a continuous Ni overlayer was plated on Cu to avoid the diffusion of Cu and to improve the oxidation resistance for the following growth of buffer layers and YBCO.

TT 1.11 Fr 12:45 TU H104

Normal and mixed state Hall effect in $(Hg_{0.9}Re_{0.1})Ba_2CaCu_2O_{6+\delta}$ fully textured HTSC thin films — •Abouelwafa Salem, Gerhard Jakob, and Hermann Adrian — Institut für Physik, Johannes Gutenberg-Universität, 55099

Temperature and magnetic field dependence of the Hall effect in the normal and mixed state of fully textured $(Hg_{0.9}Re_{0.1})Ba_2CaCu_2O_{6+\delta}$ (HgRe-1212) HTSC thin films prepared by laser ablation deposition have been studied. The longitudinal resistivity ρ_{xx} and Hall resistivity ρ_{yx} of HgRe-1212 superconductor thin films were measured for a wide range of magnetic fields up to 12 T with the field perpendicular to the ab plane and the current in the ab plane. A sign change of the Hall resistivity is observed in fields below 3 T in the region close to the superconducting onset temperature. The temperature dependencies $\rho_{xx} \propto T$ and $\rho_{yx} \propto 1/T$ have been observed for HgRe-1212 thin films. Anderson's formula for the Hall angle θ_H, namely $\cot\theta_H = \alpha T^2 + \beta$, remains valid for temperatures T above T_c. In the mixed state a power-law behavior is observed, where ρ_{yx} scales to a power-law function of ρ_{xx}: $\rho_{yx} = A\rho_{xx}^{\beta}$, with β increasing from 1.0 to 1.7 as the field increases from 1 to 12 T.