Effect of impurity additions on the superconducting properties of in situ processed MgB$_2$ — • Marko Herrmann$^1$, Margitta Schubert$^1$, Wolfgang Hässler$^1$, Bernhard Holzapfel$^2$, and Ludwig Schultz$^1$

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The MgB$_2$ powder was prepared by mechanical alloying of Mg, amorphous Boron and the additive. For studying the influence of the additive on the superconducting properties its amount was varied up to 20 mass%. Single elements as carbon as well as compounds like SiC were used as dopants. The result of the milling process was a partially reacted nanosized precursor powder with a high reactivity which was hot pressed to bulk samples. Starting from the undoped MgB$_2$ with a critical temperature of 36 K and best current densities of 10$^4$ A/cm$^2$ at 7.5 K and 4 T, the changes of the superconducting properties with the kind and amount of additive are described in detail.

TEM cross-section analysis of La$_2$Zr$_2$O$_7$ buffer layers for YBCO-coated conductors prepared by chemical solution deposition — • Marko Herrmann$^1$, Bernhard Holzapfel$^2$, and Oliver Eibl$^1$

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Chemical solution deposition is a promising method to fabricate low cost buffer layers for YBCO-coated conductors. In this study we present transmission electron microscopy (TEM) analysis of cross-sectional and plan-view prepared La$_2$Zr$_2$O$_7$ buffer layers on biaxially textured Ni-W substrates for YBCO-coated conductors prepared by chemical solution deposition methods. The La$_2$Zr$_2$O$_7$ buffer layers were deposited on 100 $\mu$m thick Ni-W substrate and were heat treated at 900°C and 1050°C. TEM cross-section samples were prepared by conventional mechanical polishing and ion milling techniques. By means of transmission electron microscopy the grain size, the buffer layer thickness, the void size and void density and the orientation of LZO with respect to the Ni substrate was determined. The Ni-W substrate interface with the La$_2$Zr$_2$O$_7$ buffer layer was also investigated. Using two-beam imaging conditions brightfield, dark-field and energy spectroscopic images (ESI) were acquired. Chemical composition determination of the films and substrate was done by energy dispersive X-ray microanalysis (EDX).
To achieve high current carrying capabilities in YBCO coated conductors based on cubic textured metal substrates, the texture and stability of the buffer/substrate interface is a necessary requirement. In this work cubic textured Ni-4 at.% W substrate tapes were subjected to different H$_2$S treatments and the texture development of post-deposited MgO buffer layers was studied. The in-plane orientation and the texture shape of the MgO layers was found to depend strongly on the heat treatment time in Ar-10 ppm H$_2$S. Increasing the time from 5 to 60 min at 800°C changes the in-plane orientation from 45° over 0° to 45° at 15 min and the texture sharpens continuously to an FWHM (220) of c°.

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Physical properties of chemically deposited La$_2$Zr$_2$O$_7$ and CeO$_2$ buffer layers on cubic textured Ni-4 at.% W substrates — ●GUNTER KOTZYBA, BERNHARD OBERST, RAINER NAST, and WILFRIED GOELDACKER Forschungszentrum Karlsruhe, Institut für Technische Physik, P.O. Box 3640, 76021 Karlsruhe

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

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dc and rf transport in normal and superconducting HTS, MgB$_2$, and Nb networks — ●JÜRGEN HALBRITTER — Forschungszentrum Karlsruhe, Postfach 36 40

Island/grain boundaries occur naturally in film growth or sintering. The hindrance of electric transport by boundary resistances $R_{\text{bound}}(W/cm^2)$ in distances $a$ (0.1-10nm) is easy to measure in normal conducting transport in such granular networks. The resistivity $\rho(T)$ is measured with percolation factors $p<1$ by current diverting $\rho(p\rho(300K))$ boundaries with $R_{\text{bound}} \geq a\rho(300K)$ where $\rho(p\rho(0))$ is due to the grain interior (IG) and $R_{\text{bound}}(a\rho)$ and $p$ describes the effects of boundaries (GB) and the network. In the superconducting transport GB may act as Josephson junctions (JJ) with $J_c(A/cm^2)$ as current density. For superconducting networks is a simple separation in IG and GB not possible. But low $J_c$ values, $p>1$ and large $R_{\text{bound}}$ val- ues are clear indications for growth boundary limitations. Analysis of $I_c(T,B,q,\omega)$ as function of temperature, field B, angle q and frequency $\omega$ give crucial information about GB and flux low or pinning of Josephson (JJ) or Abrikosov fluxons (AF) in the network. The combination of normal and superconducting analysis is of crucial importance for dc, as and rf engineering applications and for the understanding of the related material science.

TT 7.16 Mon 14:00 P1

Electronic structure calculations for YBCO/metal interfaces — ●UDO SCHWINGENSCHLÖGL and COSIMA SCHUSTER — Institut für Physik, Universität Augsburg, 86135 Augsburg

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

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


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

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Nano-meter-scale superconducting domains observed on Nd$_{1.88}$Ca$_{0.12}$O$_{1.85}$ — ▲ PINTU DAS, DIRK MAUTES, MICHAEL R. KOBELISCHKA, THOMAS WOLF, and UWE HARTMANN — Institute of Experimental Physics, University of Saarbrücken, D-66041 Saarbrücken, Germany ▲ Forschungszentrum Karlsruhe GmbH, Institut für Solid State Physics, D-76021 Karlsruhe, Germany

In understanding high temperature superconductivity, the recent fo- cus is at the local scale electronic modulation and its influence towards superconductivity in general. The granular structure and atomic-scale modulation of the density of states in Bi$_2$Sr$_2$CaCu$_2$O$_{8+x}$ have been ob- served [1,2]. Here we report Scanning Tunneling Spectroscopic (STS) re- sults obtained on the (ab) plane of a slightly underdoped Nd$_{1.88}$Ca$_{0.12}$O$_{1.85}$ ($T_c = 93.5$ K) twinned single crystals at 4.2 K. Recent results proved that the NdBCO surface is highly clean and stable in air, showing atomic res- olution at room temperature [3]. We used the STS imaging technique to study the electronic inhomogeneity and we observe that there are superconducting domains of ~ 3 nm length scale separated by nonsupercon- ducting regions, similar to that observed in Bi$_2$Sr$_2$CaCu$_2$O$_{8+x}$. In the superconducting domains, the size of the energy gap spatially varies from 16-20 meV to ~44 meV. The average gap size is found to be ~22 meV. We discuss these data and the possible origin of the inhomogeneous electronic structure of the respective materials.


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Nanostrape stripe structures in Sm$_2$Ba$_{2}$Cu$_{3}$O$_{y}$ superconductors — ●M. WINTER, M. R. KOBELISCHKA, TH. WOLF, X. YAO, A. HU, and U. HARTMANN — 1Institute of Experimental Physics, University of Saarbrücken, P.O.Box 151150, 66041 Saarbrücken, Germany ▲ Forschungszentrum Karlsruhe GmbH, Institut für Solid State Physics, D-76021, Karlsruhe, Germany ▲ Department of Physics, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai 200099, P.R. China ▲ Department of Physics, University of Waterloo, 200 Univ. Ave. West, Waterloo, ON N2L 3P7, Canada

AFM and STM scans on Sm$_2$Ba$_{2}$Cu$_{3}$O$_{y}$ (SmBCCO) melt-processed samples prepared using different techniques revealed the presence of nanoscale stripe-like structures, sometimes parallel over several microme- ters, sometimes wavy. These structures consist of chemical compositional fluctuations which act as effective pinning centers for supercurrent. The stripe length of typically 10-60 nm which is comparable to the ideal pinning- center size of 2 $\xi$ (10 nm for YBa$_2$Cu$_3$O$_y$ in the ab-plane). Com- pared to similar structures in ternary (Sm,Eu,Gd)Ba$_2$Cu$_3$O$_y$ (SEG) and (Nd,Eu,Gd)Ba$_2$Cu$_3$O$_y$ (NEG) systems, where the stripes appear either as plateau-like stripes or as chains of aligned clusters, the stripes in Sm- BCCO always appear as plateau-like stripes with a height of 1-8Å. These pinning structures throughout the whole sample volume may be a key