TT 15: SC: Fabrication and Characterization

Time: Monday 16:30–18:00 Location: HSZ 301

TT 15.1 Mon 16:30 HSZ 301

Enhanced two-dimensional behavior of metastable T′-La_2CuO_4, the parent compound of electron-doped cuprate superconductors — •Alexander Buckow[1], Roland Hord[2], Hubertus Luetkens[3], Gwendolyne Pascua[3], Kathrin Hofmann[2], Jose Kurian[1], Vladimir Pomjakushin[4], Andreas Suter[3], Barbara Albert[2], and Lambert Alff[1] — [1]Institute of Materials Science, TU Darmstadt — [2]Eduard-Zintl-Institute, TU Darmstadt — [3]Laboratory for Muon Spin Spectroscopy, PSI — [4]Laboratory for Neutron Scattering, PSI

We synthesized crystalline bulk samples of lanthanum cuprate in the metastable T' phase using cesium hydroxide flux. Its crystal structure was determined as space group $I4/mmm$, no. 139, $a = 401.02$ pm, $c = 1252.66$ pm. Muon spin rotation reveals a gradual slowing down of magnetic order below $T_{N2} = 115$ K, in sharp contrast to La_2CuO_4 in the T structure where $T_{N1} \approx T_{N2} \approx 300$ K. Our result shows that the strikingly different magnetic behavior of the two parent compounds has its origin in the two crystal structure modifications. In addition, we find that T'-La_2CuO_4 has strongly reduced magnetic interactions compared to the other T' materials Nd_2CuO_4 and Pr_2CuO_4, where Nd^{3+} and Pr^{3+} are magnetic ions in contrast to the nonmagnetic La^{3+}.

[1] R. Hord, H. Luetkens, G. Pascua, A. Buckow, K. Hofmann, Y. Krockenberger, J. Kurian, H. Maeter, H.-H. Klauss, V. Pomjakushin, A. Suter, B. Albert, and L. Alff, Phys. Rev. B **82**, 180508(R) (2010).

TT 15.2 Mon 16:45 HSZ 301

Preparation and characterization of $YBa_2Cu_3O_{7-\delta}$ thin films on piezoelectric substrates — •Patrick Pahlke, Sascha Trommler, Ruben Hühne, Bernhard Holzapfel und Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, PO Box 270116, D-01171 Dresden, Germany

The electronic properties of superconducting materials are correlated to external strain. A suitable approach to study this interplay is the preparation of thin superconducting films on piezoelectric substrates. The lattice parameter of theses substrates can be tuned continuously by applying an electric field. Superconducting $YBa_2Cu_3O_{7-\delta}$ (YBCO) thin films were successfully prepared on single crystalline piezoelectric (001) $Pb(Mg_{1/3}Nb_{2/3})_{0.72}Ti_{0.28}O_3$ substrates using off-axis pulsed laser deposition. Transport measurements revealed a superconducting transition temperature of $T_{c,50} = 89$ K with a transition width of 1 K. By inducing a biaxial strain of 0.2 % in the a-b plane of YBCO a shift of the superconducting transition temperature of $\Delta T_{c,50} = 0.1$ K was observed for optimally doped YBCO. A significant larger effect was found for underdoped samples. We will present the results of these straining experiments and the detailed structural analysis of the grown films. Furthermore our investigations on low temperature properties of the used PMN-PT substrates, which are required for the evaluation of the applicable strain in this temperature region, will be discussed.

TT 15.3 Mon 17:00 HSZ 301

Electric and Magnetic Characterization of La-doped $Bi_2Sr_{2-x}La_xCuO_6$ single crystals — •Michael R Koblischka[1], Johannes Lillig[1], Michal Rames[2], Milos Jirsa[2], Huiqian Luo[3], Hai-Hu Wen[3], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, Saarland University, P.O.Box 151150, D-66041 Saarbrücken, Germany — [2]Institute of Physics, ASCR, Na Slovance 2, CZ-182 21 Prague, Czech Republic — [3]National Laboratory for Superconductivity, P.O.Box 603, Beijing, 100190, P.R.China

We present an exhaustive electric and magnetic characterization of La-doped $Bi_2Sr_{2-x}La_xCuO_6$ single crystals. The critical temperature, T_c, is varying from 27 K to 0 depending on the La content with a maximum at $x = 0.4$. For the measurements we selected samples with $x = 0.4$ (optimally doped) and $x = 0.6$ (slightly underdoped). The sample $x = 0.6$ shows an onset of superconductivity at 25 K and a transition width of 3.5 K. However, at temperatures lower than 20 K, a clear upturn of the resistance curve is found, which also depends on the applied field and the flowing current. The origin of this behavior is discussed.

TT 15.4 Mon 17:15 HSZ 301

Fabrication of superconducting MgB_2 thin films by magnetron co-sputtering on (001) MgO substrates — •Savio Fabretti, Patrick Thomas, Markus Meinert, and Andy Thomas — Bielefeld University, Germany

We fabricated superconducting MgB_2 thin films on (001) MgO substrates. The samples were prepared by magnetron rf and dc co-sputtering on heated substrates. They were annealed ex-situ for one hour at temperatures between 450°C and 750°C. We will show that the substrate temperature during the sputtering process and the post annealing temperatures play a crucial role in forming MgB_2 superconducting thin films. We achieved a critical onset temperature of 27.1 K for a film thickness of 30 nm. The crystal structures were measured by x-ray diffraction.

TT 15.5 Mon 17:30 HSZ 301

Gallium nanolayers featuring on-chip superconductivity in silicon — •Richard Skrotzki[1], Thomas Herrmannsdörfer[1], Jan Fiedler[1,2], Viton Heera[1], Matthias Voelskow[1], Arndt Mücklich[1], Bernd Schmidt[1], Wolfgang Skorupa[1], Gerhard Gobsch[2], Manfred Helm[1], and Joachim Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory (HLD) and Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 51 01 19, D-01314 Dresden, Germany — [2]Experimental Physics, Institute of Physics, Ilmenau University of Technology, Weimarer Str. 32, 98693 Ilmenau, Germany

We demonstrate the feasibility of embedding superconducting Ga nanolayers in commercial (100) oriented silicon wafers and discuss the possibility of potential device applications [1]. Ion implantation and rapid thermal annealing, known as versatile tools of microelectronic technology, have been used for inserting and distributing a gallium dose of up to 4×10^{16} cm^{-2}. As proven by structural analysis, a 10 nm thin layer of amorphous Ga-rich precipitates forms during annealing at 600 - 700°C. These structures exhibit a superconducting transition at 7 K. Extended resistivity and magnetization measurements reveal in-plane critical fields around 14 T and critical current densities exceeding 2 kA/cm^2. In summary, we proceed with an optimistic outlook concerning the implementation of prospective microstructuring. After all, this would be the next step towards the development of novel semiconductor-based superconducting devices.

[1] R. Skrotzki et al., Appl. Phys. Lett. 97, 192505 (2010)

TT 15.6 Mon 17:45 HSZ 301

Structural characterization of buried superconducting Ga rich films in Si — •Jan Fiedler[1,2], Viton Heera[1], Richard Skrotzki[1], Thomas Herrmannsdörfer[1], Matthias Voelskow[1], Arndt Mücklich[1], Bernd Schmidt[1], Wolfgang Skorupa[1], Gerhard Gobsch[2], Manfred Helm[1], and Jochen Wosnitza[1] — [1]Institute of Ion Beam Physics and Materials Research and Dresden High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 51 01 19, D-01314 Dresden, Germany — [2]Experimental Physics, Institute of Physics, Ilmenau University of Technology, Weimarer Str. 32, 98693 Ilmenau, Germany

Recently it has been shown that heavily p-doped group-IV semiconductors such as diamond, silicon and germanium can become superconducting at low temperatures. Here, we present a study of Ga-implanted Si that becomes superconducting due to precipitation after annealing. Ion implantation allows introducing a high Ga dose (4E16cm-2) in Si that leads to peak concentrations far beyond the solid solubility limit. Rapid thermal annealing (RTA) causes redistribution of the Ga and re-crystallization of the amorphous implanted Si layer. After annealing at temperatures up to 850°C the implanted layers are polycrystalline and contain Ga-rich precipitates. Structural investigations by means of RBS/C measurements and TEM demonstrate a high density of precipitates at the interface of a protective SiO2 layer and the silicon substrate. At optimized annealing conditions (600-700°C) such samples become superconducting with critical temperatures up to 7 K [1].

[1] Skrotzki R. et al. , Appl. Phys. Lett. 97 (2010) 192505