TT 18: Superconductivity: Fabrication and Characterization

Time: Tuesday 14:00–16:00 Location: HSZ 105

TT 18.1 Tue 14:00 HSZ 105

Crystal Growth and Characterization of $Ba_{1-x}K_xFe_2As_2$ — •Andreas Erb, Franz Czeschka, Monika Bahurupi, and Rudolf Gross — Walther Meissner Institut für Tieftemperaturforschung, Bayerische Akademie der Wissenschaften, Walther Meissnerstr. 8, 85748 Garching, Germany

We report on the growth and characterization of single crystals of $Ba_{1-x}K_xFe_2As_2$ by electrical transport and magnetization measurements. The crystals were grown from high temperature solutions using tin as a flux. Crystals of several mm size in a-b direction can be grown exhibiting sharp superconducting transitions in both resistive and magnetic measurements. We discuss the problem of intrinsic inhomogeneity of the as-grown crystals as a consequence of the phase diagram for this solid solution system. We also outline scenarios for the application of other crystal growth techniques. This work is supported by DFG within the Research Unit 538.

TT 18.2 Tue 14:15 HSZ 105

Preparation and Analysis of the new Superconductors $RO_{1-x}F_xFeAs$ (R = La, Ce, Nd, Sm, Gd) — •Anke Köhler, Günter Behr, Jochen Werner, Daniel Koksch, Rüdiger Klingeler, Norman Leps, Jorge E. Hamann-Borrero, and Bernd Büchner — IFW Dresden, PF 270116, D-01171 Dresden

Polycrystalline samples of $RO_{1-x}F_xFeAs$ ($0 \leq x \leq 0.25$) were prepared in a two step method, similar described by Zhu et al. . In the first step FeAs is prepared which is milled afterwards. In the second step the FeAs powder is mixed together with rare-earth-oxides, -flourides and -pure element powders and pressed into pellets under a well defined pressure. Then, the samples were heated in an evacuated silica tube at 940°C and 1150°C. The composition of the samples and particularly the fluorine content was determined by wavelength-dispersive X-ray spectroscopy (WDX) in the electron microscope. The polycrystalline samples consist of the $RO_{1-x}F_xFeAs$ phase mainly, only small amount of RO_yF_z and FeAs are found. We find that the measured fluorine content can deviate from the initial weight. In the lanthanum compound $LaO_{1-x}F_xFeAs$, e.g., we found a good agreement mainly for $x>0.05$, but the fluorine hardly goes into the sample for $x<0.05$. For the samarium compound again we measure less fluorine in the sample as weighted for all fluorine contents. These measured values are taken into account when drawing the electronic phase diagrams of $LaO_{1-x}F_xFeAs$ and $SmO_{1-x}F_xFeAs$. Furthermore, we studied which preparation steps are crucial for the fluorine incorporation.

TT 18.3 Tue 14:30 HSZ 105

Growth and anisotropy of La(O,F)FeAs thin films deposited by pulsed laser deposition — •Elke Backen[1], Silvia Haindl[1], Tim Niemeier[1], Ruben Hühne[1], Thomas Freudenberg[1], Jochen Werner[2], Günter Behr[2], Ludwig Schultz[1], and Bernhard Holzapfel[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]IFW Dresden, Institute for Solid State Research, P.O. Box 270116, D-01171 Dresden, Germany

$LaFeAsO_{1-x}F_x$ thin films were deposited successfully on (001)-oriented $LaAlO_3$ and MgO substrates from stoichiometric $LaFeAsO_{1-x}F_x$ polycrystalline targets with fluorine concentrations up to $x = 0.25$ by pulsed laser deposition (PLD). Room temperature deposition and post annealing yield films with a pronounced c-axis texture and a strong biaxial in-plane orientation. Transport measurements show metallic resistance and onset of superconductivity at 11 K. $\mu_0H_{c2}(T)$ was determined by resistive measurements and yield μ_0H_{c2} values of 3 T at 3.6 K for the perpendicular field direction and 6 T at 6.4 K for the parallel field direction to the sample surface.

TT 18.4 Tue 14:45 HSZ 105

Texture and anisotropy of PLD-grown superconducting $LuNi_2B_2C$ thin films — •Tim Niemeier[1], Ruben Hühne[1], Günter Fuchs[1], Anke Köhler[2], Günther Behr[2], Ludwig Schultz[1], and Bernhard Holzapfel[1] — [1]Institute for Metallic Materials, IFW Dresden, P.O. Box 270116, D-01171 Dresden — [2]Institute for Solid State Physics, IFW Dresden, P.O. Box 270116, D-01171 Dresden

Epitaxial thin films of $LuNi_2B_2C$ were deposited on MgO single crystal substrates using Pulsed Laser Deposition from a stoichiometric target. The film thicknesses are around 200 nm. For optimized deposition parameters, a sharp c-axis texture, high in-plane order and a good reproducibility were achieved. The residual resistivity is around 5 $\mu\Omega$cm, which is about 2-3 times higher than the best values reported for single crystals, resulting in RRR values of about 15. The temperature behaviour of the upper critical field was measured using a Quantum Design PPMS between 2K and T_c and reveals a significantly higher H_{c2} than in single crystals whereas the anisotropic behaviour of H_{c2} is qualitatively similar. Potential reasons for the increase of H_{c2} are discussed.

15 min. break.

TT 18.5 Tue 15:15 HSZ 105

Ion-beam assisted deposition of textured transition metal nitride films — •Martin Kidszun, Ruben Hühne, Bernhard Holzapfel und Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

Ion-beam assisted deposition (IBAD) offers the opportunity to prepare thin textured films on non-textured substrates. A textured nucleation was observed in materials with a rocksalt structure like MgO or TiN under appropriate deposition conditions. Therefore, the IBAD approach was used to investigate, if other superconducting transition metal nitrides can be textured in a similar way. The films were prepared on amorphous Si3N4 seed layers in a reactive process using pulsed laser deposition of pure metals in combination with a nitrogen containing ion-beam. The texture development was studied in-situ using reflection high-energy electron diffraction. It was found, that NbN reveals a textured nucleation similar to MgO or TiN. The biaxial texture was stabilised to thicker layers using homoepitaxial growth. Highly textured NbN layers were realised on amorphous substrates with an in-plane alignment below 5°. In dependence of the nitrogen pressure applied during the homoepitaxial growth, superconducting transition temperatures up to 14 K were observed. A clear correlation between structural and superconducting properties was found. Additionally, the oxygen incorporated in the NbN layer has a significant influence on the superconducting properties. Finally, a textured nucleation was also found for the reactive preparation of ZrN using ion-beam assisted laser deposition.

TT 18.6 Tue 15:30 HSZ 105

Magnetic measurements under pressure of the non-centrosymmetric superconductor Li_2Pd_3B synthesized by a semi-open method — •P. Badica[1,2], G. Jakob[1], A. Beleanu[1], V. Ksenofontov[1], and C. Felser[1] — [1]Mainz University, Mainz, Germany — [2]National Institute of Materials Physics, Bucharest, Romania

Samples of the non-centrosymmetric superconductor Li_2Pd_3B were synthesized from mixtures of the elements. A simple semiopen method is proposed using endings-pressed stainless steel tubes placed in a vacuum furnace. Heating regime employed a short-time overheating at 900 ° C and a slow cooling step between 720 to 550 ° C with a constant cooling rate of 1 ° C/min. Extra amount of Li was necessary to compensate losses and the optimum starting composition was $Li_{2.4}Pd_3B$. Superconducting properties, such as lower and upper critical fields and critical temperature T_c, were measured by magnetic measurements (MPMS magnetometer) under hydrostatic pressures up to 2 GPa (using a self-made pressure capsule). Superconducting properties are decreasing with pressure. For example, under normal pressure samples show a critical temperature of 8-8.2 K and a sharp superconducting transition, while the results indicate for the decrease rate dT_c/dP a value of 0.12 K/GPa. This value is about 3 times lower than the reported value measured by transport measurements on arc-melted samples.

TT 18.7 Tue 15:45 HSZ 105

Phase evolution of $BaHfO_3$ pinning centers in YBCO thin films fabricated with the TFA-MOD process — •Thomas Thersleff, Sebastian Engel, Jens Hänisch, Robert Kluge, Ruben Hühne, Ludwig Schultz, and Bernhard Holzapfel — IFW-Dresden, P.O. Box 270116, 01171 Dresden, Germany

Exploiting the exceptional electrical and magnetic properties of superconducting $YBa_2Cu_3O_{7-\delta}$ (YBCO) coated conductors for the commercial market requires both an economical deposition process as well

as a means of enhancing the pinning of magnetic flux lines to increase performance of these materials in applied magnetic fields. Introducing nanosized $BaHfO_3$ (BHO) particles into a YBCO layer deposited using the well-documented chemical solution deposition route known as TFA-MOD is one way to achieve both of these goals. However, the conversion from a precursor solution to crystalline YBCO is complicated and not fully understood, particularly when nanoparticles are added. This contribution takes a closer look at the phase evolution of these nanoparticles in the TFA-MOD-based process. Films with varying concentrations of BHO particles were quenched at different temperatures during the conversion process. Transport and inductive measurements on the fully reacted samples with BHO particles indicate an increased pinning effect with higher dopant concentrations. X-ray results reveal the formation of BHO particles before YBCO is observed, suggesting they precipitate at the substrate. Finally, FIB cuts and TEM cross-section images provide a robust characterization of these films at various stages of the conversion process.