TT 57: SC: Fe-based Superconductors - 122 - Thin Films

Time: Thursday 17:15–18:45 Location: HSZ 304

TT 57.1 Thu 17:15 HSZ 304

New routes for epitaxial thin films of Fe-based superconductors — Thomas Thersleff, •Silvia Haindl, Kazumasa Iida, Fritz Kurth, Jan Engelmann, Martin Kidszun, Sascha Trommler, Jens Hänisch, Alexander Kauffmann, Elke Reich, Ruben Hühne, Darius Pohl, Andreas Hartmann, Bernd Rellinghaus, Ludwig Schultz, and Bernhard Holzapfel — Institute for Metallic Materials, IFW Dresden

With the recent discovery of the Fe-based superconductors, a major question raised is their suitability for applications. Many of the most interesting devices require the controlled production of thin films with clean interfaces. During the laboratory production of Fe-based superconductor thin films, a detailed analysis by TEM of the substrate/film interface revealed evidence for secondary phase formation. On the basis of the observation of the formation of an Fe layer at the substrate/film interface for Co-doped $BaFe_2As_2$, we designed a bonding scheme between Fe and the iron pnictide phase, resulting in a new thin film architecture we have termed the ′Fe/Ba-122′ bilayer system. The first results from this system reveal greatly enhanced growth properties and critical current densities with regard to deposition on pure oxide substrates and may provide a key to understanding a more general growth mechanism in this system.

TT 57.2 Thu 17:30 HSZ 304

Dynamic studies on the influence of strain on superconducting properties using piezoelectric substrates — •Sascha Trommler, Ruben Hühne, Kazumasa Iida, Silvia Haindl, Jens Hänisch, Patrick Pahlke, Thomas Thersleff, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The interplay between structural parameters and superconducting properties attracts high interest in particular regarding the iron based superconductors. In contrast to the cuprate family, superconductivity of the latter can be induced using either pressure or chemical substitution. Nevertheless little is known about this relationship when biaxial strain is applied. The generation of biaxial strain by the preparation of thin films on substrates with different lattice mismatch is well established for cuprates. However, high quality films are necessary to correlate structural changes with electronic properties. In this work an alternative approach is used. Single crystalline piezoelectric substrates offer the unique opportunity to tune the lattice parameters continuously using the inverse piezoelectric effect. We prepared thin epitaxial $La_{1-x}Sr_xCuO_4$ and $BaFe_{2-x}Co_xAs_2$ films on piezoelectric (001) $Pb(Mg_{1/3}Nb_{2/3})_{0.72}Ti_{0.28}O_3$ (PMN-PT) substrates. A reversible shift of the superconducting transition has been achieved with a value of 0.44 K for $La_{1.85}Sr_{0.15}CuO_4$ and 0.2 K for $BaFe_{1.8}Co_{0.2}As_2$ for a biaxial strain of 0.022% and 0.017%, respectively.

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Epitaxial growth of superconducting $Ba(Fe_{1-x}Co_x)_2As_2$ thin films on IBAD-MgO buffered metallic substrates — •Jens Hänisch[1], Kazumasa Iida[1], Sascha Trommler[1], Vladimir Matias[2], Tom Thersleff[1], Fritz Kurth[1], Irene Lucas del Pozo[1], Jan Engelmann[1], Silvia Haindl[1], Ruben Hühne[1], Ludwig Schultz[1], and Bernhard Holzapfel[1] — [1]IFW Dresden, P. O. Box 270116, 01171 Dresden, Germany — [2]MPA-STC, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

Recently we have shown that thin Fe buffer layers are beneficial for the growth of high-quality $Ba(Fe_{1-x}Co_x)_2As_2$ (Ba-122) thin films.[1] Even on MgO with large lattice mismatch, epitaxial growth can be achieved with Fe buffer. Here, we report on the biaxially textured growth of superconducting Ba-122 thin films on metallic technical tapes with an ion beam assisted deposition MgO (IBAD-MgO) and Fe buffer architecture. The epitaxial relation was confirmed to (001)[100]Ba-122‖(001)[110]Fe‖(001)[100]MgO by XRD θ-2θ scans and pole figure measurements. The iron pnictide layer showed a T_c of 21.5 K, which is only slightly lower than on single-crystal MgO substrates. The angular-dependent critical current density, $J_c(\theta)$, showed a broad maximum at $\theta = 90°$ and a lower J_c anisotropy than films on single-crystalline substrates. A self-field J_c of $8{\times}10^5$ A/cm^2 has been achieved at 4 K.

[1] T. Thersleff et al., APL 97, 022506 (2010);
K. Iida et al., APL 97, 172507 (2010)

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Transport properties of thin $Ba(Fe,Co)_2As_2$ film microbridges — •Dagmar Rall[1,2], Konstantin Il'in[1], Kazumasa Iida[3], Silvia Haindl[3], Fritz Kurth[3], Thomas Thersleff[3], Ludwig Schultz[3], Bernhard Holzapfel[3], Uli Lemmer[2], and Michael Siegel[1] — [1]Institut für Mikro- und Nanoelektronische Systeme (IMS), Karlsruher Institut für Technologie, Hertzstrasse 16, 76187 Karlsruhe — [2]Lichttechnisches Institut (LTI), Karlsruher Institut für Technologie, Engesserstrasse 13, 76131 Karlsruhe — [3]Institute for Metallic Materials (IMW), IFW Dresden, p. o. box 270116, 01171 Dresden

The critical current density of $Ba(Fe,Co)_2As_2$ thin film microbridges was evaluated from current-voltage characteristics measured using the standard four-probe technique. The $Ba(Fe,Co)_2As_2$ films were deposited by pulsed-laser deposition on heated $(La,Sr)(Al,Ta)O_3$ substrates and patterned by means of photolithography and ion milling. The critical current density at T = 4.2 K reaches about 3 MA/cm^2. The experimentally obtained temperature dependence of the critical current density is described by $(1-T/T_c)^{1.5}$ in the unexpectedly wide temperature range $0.4 < T/T_c < 1$. The results can be explained in the frame of Ginzburg-Landau theory for the de-pairing critical current. The expulsion of magnetic vortices is considered as a mechanism which is responsible for overcoming Likharev's limit for observation of the de-pairing critical current.

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Thin film hybrid Josephson junctions with Co doped Ba-122. — •Stefan Schmidt[1], Sebastian Döring[1], Frank Schmidl[1], Volker Tympel[1], Veit Grosse[1], Silvia Haindl[2], Kazumasa Iida[2], Fritz Kurth[2], Ingolf Mönch[3], Bernhard Holzapfel[2], and Paul Seidel[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena, Germany — [2]IFW Dresden, Institut für metallische Werkstoffe, Helmholtzstrasse 20, 01069 Dresden, Germany — [3]IFW Dresden, Institut für Integrative Nanowissenschaften, Helmholtzstrasse 20, 01069 Dresden, Germany

Josephson junctions are a strong tool to investigate fundamental superconducting properties, such as gap behaviour, dependencies from external fields and the order parameter symmetry. Finding secure values enables the possibility of theoretical descriptions to understand the physical processes within the new iron-based superconductors. Based on Co-doped $BaFe_2As_2$ (Ba-122) layers produced via pulsed laser deposition (PLD) on $(La,Sr)(Al,Ta)O_3$ substrates, we manufactured superconductor-normal conductor-superconductor (S-N-S) junctions structures by using photolithography, ion beam etching as well as insulating SiO_2 layers. We present working Ba-122 / Au / PbIn thin film Josephson junctions with different contact areas and barrier thicknesses, their temperature dependence and response to microwave irradiation. The calculated I_cR_N product is in the range of a couple of microvolts.

TT 57.6 Thu 18:30 HSZ 304

Tunnelling spectroscopy of $BaFe_2As_2$ / Au / PbIn thin film junctions — •Sebastian Döring[1], Stefan Schmidt[1], Frank Schmidl[1], Volker Tympel[1], Veit Grosse[1], Silvia Haindl[2], Kazumasa Iida[2], Fritz Kurth[2], Bernhard Holzapfel[2], and Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, 07743 Jena — [2]IFW Dresden, Institut für metallische Werkstoffe, Helmholtzstrasse 20, 01069 Dresden

Tunnelling spectroscopy is an important tool to investigate the properties of iron-based superconductors. In contrast to commonly used point contact Andreev reflection (PCAR) technique, we fabricated hybrid superconductor / normal metal / superconductor (SNS) thin film structures, with tunable barrier thickness and area.

For the base electrode we use $Ba(Fe_{0.9}Co_{0.1})_2As_2$ thin films, produced via pulsed laser deposition (PLD). A gold layer was sputtered to form the barrier, while the counter electrode material is the conventional superconductor PbIn with a T_c of 7.2 K.

For temperatures below 7.2 K the spectrum shows a subharmonic gap structure (SGS), described by an extended model of Octavio, Tinkham, Blonder and Klapwijk (OTBK), while at higher temperatures the SGS vanishes and an SN-like behaviour can be observed.