Abstract of Presentation

Homogeneous 122-type superconductors via alternative synthesis concepts

Abstract :

Among the iron-based superconductors, potassium-doped BaFe2As2 (BaK122) [1] is one of the most promising candidate to become a technical material. This compound exhibits a Tc up to 38 K [2], large critical fields (75-100 T) [3] with low anisotropy [4] and is relatively easy to synthesize even as single crystals. On the other hand, a series of publications [5-7] reported that alkaline-metal doped 122-compounds tend to be inhomogeneous in contrast to Cobalt-doped materials [8]. Nevertheless, potassium-doped BaK122 has superior superconducting properties, and it is thus essential to overcome this alleged drawback.

From the chemical point of view, the frequently observed inhomogeneity of BaK122 is not expected to be an intrinsic property of the compound itself [9], but a consequence of poorly controlled sample synthesis. Especially the precise Ba:K ratio is hardly to control by simple solid state reaction of bulk elements, which have been used throughout so far. One reason may be the inmiscibility of potassium and barium metal. We propose alternative synthetic pathways to high-quality BaK122 samples. One concept is developing reactive precursors by using chemistry in liquid ammonia. We expect homogeneous Ba:K distributions at the atomic or at least nanoscopic scale in the precursor material, which will be subsequently reacted with appropriate iron and arsenide components. Another way is to explore metathesis procedures, which benefit from driving the reactions as desired by forming stable salts as byproducts, which can easily be removed. Such reactions do not need elemental iron as reactant, thus magnetic impurities caused by iron metal will be excluded. Finally, alkaline metal containing iron arsenide materials can also be synthesized by the azide method, which avoids handling with highly reactive elemental alkaline metal.

Preliminary experiments in our lab already proved the above mentioned methods as possible pathways, which may be used to optimize BaK122 samples with respect to homogeneity and easier production. Detailed procedures have to be developed during the project. High quality homogeneous samples of BaK122 can be used to elucidate fundamental open questions regarding the pairing symmetry or the coexistence of magnetism and superconductivity, e.g. by groups using NMR or other methods, and can also be supplied to groups who investigate superconducting properties like critical fields,

Abstract of Presentation

critical currents, properties of the mixed state or other issues with respect to technical applications.

[1] M. Rotter, M. Tegel, I. Schellenberg, W. Hermes, R. Pöttgen, D. Johrendt, Phys. Rev. B 2008, 78, 020503(R).

[2] M. Rotter, M. Tegel, D. Johrendt, Phys. Rev. Lett. 2008, 101, 107006.

[3] N. Ni, S. L. Bud'ko, A. Kreyssig, S. Nandi, G. E. Rustan, A. I. Goldman, S. Gupta, J. D. Corbett, A. Kracher, P. C. Canfield, Phys. Rev. B 2008, 78, 014507.

[4] H. Q. Yuan, J. Singleton, F. F. Balakirev, S. A. Baily, G. F. Chen, J. L. Luo, N. L. Wang, Nature 2009, 457, 565.

[5] H. Fukazawa, T. Yamazaki1, K. Kondo, Y. Kohori, N. Takeshita, P. M. Shirage, K. Kihou, K. Miyazawa, H. Kito, H. Eisaki, A. Iyo, J. Phys. Soc. Jpn. 2009, 78, 033704.

[6] J. T. Park, D. S. Inosov, C. Niedermayer, G. L. Sun, D. Haug, N. B. Christensen, R. Dinnebier, A. V. Boris, A. J. Drew, L. Schulz, T. Shapoval, U. Wolff, V. Neu, X. Yang, C. T. Lin, B. Keimer, V. Hinkov, Phys. Rev. Lett. 2009, 102, 117006.

[7] D. S. Inosov, A. Leineweber, X. P. Yang, J. T. Park, N. B. Christensen, R. Dinnebier, G. L. Sun, C. Niedermayer, D. Haug, P. W. Stephens, J. Stahn, O. Khvostikova, C. T. Lin, O. K. Andersen, B. Keimer, V. Hinkov, Phys. Rev. B 2009, 79, 224503.

[8] Y. Laplace, J. Bobroff, F. Rullier-Albenque, D. Colson, A. Forget, Phys. Rev. B 2009, 80, 140501.

[9] M. Rotter, M. Tegel, I. Schellenberg, F. M. Schappacher, R. Pöttgen, J. Deisenhofer, A. Gunther, F. Schrettle, A. Loidl, D. Johrendt, New J. Phys. 2009, 11, 025014.