Doping Evolution of the Anisotropic Upper Critical Field in Iron-Based Superconductor $Ba_{1-x}K_xFe_2As_2$

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Introduction

Several reports recently suggested that the upper critical field of overdoped compositions of hole-doped iron-based superconductors $Ba_{1-x}K_xFe_2As_2$ close to x=1 reveal paramagnetic limiting features [1,2]. To check if this behavior is universal for these materials we performed comparative studies of compositions covering the broad range of the compositional phase diagram, with accent of comparison of under-doped and over-doped compositions.

Experimental

In-plane resistivity measurements as a function of temperature, magnetic field up to 35T and its orientation with respect to the crystallographic ab-plane were used to study the upper critical field, H_{c2}, of the hole-doped iron-based superconductor $Ba_{1-x}K_xFe_2As_2$. Measurements were performed using precise alignment (with accuracy less than 0.1^o) of magnetic field with respect to the Fe-As-plane. Measurements were performed in 35 T resistive magnet of DC facility of NHMFL in Tallahassee, Florida.

Results and Discussion

Compositions of the samples studied were spanning from underdoped *x*=0.17 (T_c=12~K) and *x*=0.22 (T_c=20K), both in the coexistence range of magnetism and superconductivity, though optimally doped samples *x*=0.39 (T_c=38.4 K), *x*=0.47 (T_c=38.5~K), *x*=0.56 (T_c=37.2~K), to overdoped *x*=0.65 (T_c=22~K), *x*=0.83 (T_c=10~K). We find notable deviations from scaling between T_c and H_{c2} in the underdoped range of the phase diagram, suggesting important role of interaction between superconductivity and long range magnetic ordering. This is illustrated in Fig.1 which shows magnetic field-temperature phase diagrams for heavily under-doped sample *x*=0.17 and heavily overdoped sample *x*=0.83 with similar values of T_c. In magnetic field parallel to the plane the latter shows clear saturation as expected for paramagnetic limiting, while the former shows significantly higher H_{c2} values and mild saturation [3].

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References

[1] Zocco, D.A., *et al*., Phys. Rev.Lett., **111**, 057007 (2013).
[2] Terashima, T., *et al*., Phys. Rev.B., **87**, 184513 (2013).
[3] Tanatar, M.A., *et al*., Phys. Rev.B., in preparation.

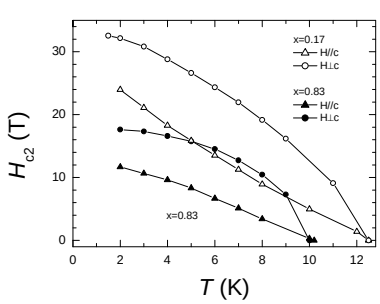

Fig.1 Magnetic field-temperature phase diagram of under-doped (x=0.17) and over-doped (x=0.83) compositions of BaK122. Note strong saturation of Hc2(T) curve on T going to zero in overdoped case and the lack of this feature in the under-doped case.