Generalized Superconducting Phase Diagrams of the Fe Arsenides

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Introduction

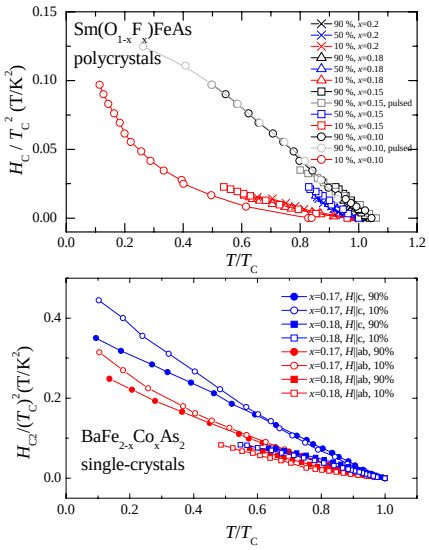
The discovery of the new iron based pnictide high temperature superconductors has taken the community by surprise and has open the prospect of developing an entire new family of new superconductors with unique characteristics. Many of the physical properties unveiled so far indicate that they are unique in many aspects but in particular quite distinct to cuprates, e.g. multiband character, not doped Mott insulators, possibility of multi-gap superconductivity, smaller anisotropy, etc. In order to understand their properties and potentiality for applications it is of paramount importance to determine and understand in detail their superconducting phase diagram under an applied external field.

Experimental

Essentially we measured the resistivity as a function of temperature for polycrystalline $Sm(O_{1-x}F_x)FeAs$ and single crystalline $Ba(Fe_{2-x}Co_x)As_2$ single crystals in order to explore the resistive superconducting transition as a function of temperature and doping and extract the respective phase-diagrams. We used the resistive magnets, respectively cells 8 and 12, coupled to cryogenic facilities.

Results and Discussion

Top figure: Renormalized phase superconducting phase-diagram for $Sm(O_{1-x}F_x)FeAs$ polycrystalline material for several doping levels *x*. Black markers correspond to the onset (90%), blue markers to the middle point (50%) and red markers to the foot of the resistive transition. Notice the nearly linear dependence for the onset of the transition and the upward curvature for the foot of the transition. Bottom: attempt of scaling for two dopings of $Ba(Fe_{2-x}Co_x)As_2$ single crystalline material. The clean limit like expected scaling fails in this case.



Conclusions

Polycrystalline $Sm(O_{1--x}F_x)FeAs$ satisfies a scaling relation that is expected for superconductors in the clean limit despite the fact that these samples are known to contain impurity phases. The small coherence length is such that the Cooper is not affected by these impurities. While surprisingly single crystalline $Ba(Fe_{2-x}Co_x)As_2$ does not satisfy any of the simple scaling relations for either the clean or the dirty limit indicating that different doping levels are in different regimes. This may not be surprising giving the coexistence of superconductivity with antiferromagnetism in underdoped samples.

Acknowledgements

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References

[1] See for example, J. Jaroszynski *et al.*, Phys. Rev. B **78** 064511 (2008).