

Anisotropic London Penetration Depth in Iron-based Pnictide Superconductors

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I will summarize measurements of the London penetration depth, $\lambda(T)$, in single crystals of iron-based pnictide superconductors comparing the “1111”, “11” and “122” families and discuss the compatibility of our results with other gap sensitive probes, such as ARPES, NMR, tunneling and thermal conductivity. A detailed discussion of the doping dependent penetration depth will be given for the well-characterized “122” family, $(\text{Ba}_{1-y}\text{K}_y)(\text{Fe}_{1-x}\text{T}_x)_2\text{As}_2$ ($T=\text{Co, Ni, Pd, Rh}$). Overall, penetration depth exhibits a power law variation at low temperatures, $\lambda(T)=\lambda(0)+bT^n$ (down to 80 mK in the case of FeNi-122). The exponent n is typically less than 2.8, which is clearly different from the exponential behavior expected for conventional clean fully-gapped s-wave superconductors. The low-temperature parameters, $\lambda(0)$, b and n depend on the doping level, x . This is best seen in the out-of-plane penetration depths, $\lambda_c(T)$, which at least in the FeNi-122 system, changes from a high power in the underdoped regime to T -linear in overdoped samples. Furthermore, analysis of the superfluid density in the full temperature range is consistent with two-gap superconductivity. However, the temperature dependencies of the anisotropies, λ_c/λ_{ab} and ξ_c/ξ_{ab} , are opposite compared to a well-known two-gap superconductor, MgB_2 . Consistency of these results with theories that explain the power law behavior to be due to scattering in a two-dimensional $s_{+/-}$ model will be discussed. Overall, our results suggest that the superconducting gap in iron-based pnictide superconductors develops nodal structure in the overdoped regime with nodes located at finite k_z wave vectors on a three-dimensional Fermi surface.

References:

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