MAR10-2009-000347

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

## Anisotropic London Penetration Depth in Iron-based Pnictide Superconductors

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The temperature dependent London penetration depth, $\lambda(T)$, is linked directly to the structure of the superconducting gap, thus providing valuable insight into the pairing mechanism. I will summarize measurements of the penetration depth in single crystals of iron-based pnictide superconductors comparing the "1111", "11" and "122" families. Compatibility of our results with other gap sensitive probes, such as ARPES and thermal conductivity, will be addressed. A detailed discussion of the doping dependent penetration depth will be given for the well-characterized "122" family, $(Ba_{1-y}K_y)(Fe_{1-x}T_x)_2As_2$ (T=Co, Ni, Pd, Rh). Overall, $\lambda(T)$ 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 $n \approx 4$ that parameterizes the exponential behavior expected for conventional fully gapped s-wave superconductors. The low-temperature parameters, $\lambda(0)$, $b$ and $n$ depend on the doping level and the orientation of a magnetic field with respect to the crystal axes. This evolution is best observed 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. Simultaneously, the in-plane penetration depth, $\lambda_{ab}(T)$, evolves towards a sub-quadratic behavior with $n \approx 1.7$. Furthermore, analysis of the superfluid density in the full temperature range is consistent with two-gap superconductivity. However, the temperature dependencies of the anisotropies, $\lambda_c/\lambda_{ab}$ and $\xi_{ab}/\xi_c$, are opposite compared to another 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 $s_\pm$ 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:** C. Martin *et al.*, Phys. Rev. Lett. **102**, 247002 (2009); R. T. Gordon *et al.*, Phys. Rev. Lett. **102**, 127004 (2009); R. T. Gordon *et al.*, Phys. Rev. B **79**, 100506(R) (2009)