Critical Fields of P-doped Ba-122 Thin Films

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Introduction

$BaFe_2(As_{1-x}P_x)_2$ (P-doped Ba122) is an Fe-based superconductor with a quantum critical point which manifests in a strong effective mass enhancement near optimum doping, and therefore a strong dependence of London penetration depth λ and condensation energy on the P-content, as measured recently on single crystals.[1,2] For H||ab, the upper critical field H_{c2} is found to be paramagnetically limited, H_{c2}||c seems to show less two-band effects than known from other members of the Ba122 family, such as Co-doped Ba-122. Here, we investigate the influence of geometry and strain as well as Fe stoichiometry on the phase diagram of P-doped Ba122 in form of thin films. These investigations are important to fully understand the transport properties of P-doped Ba122 thin films.[3]

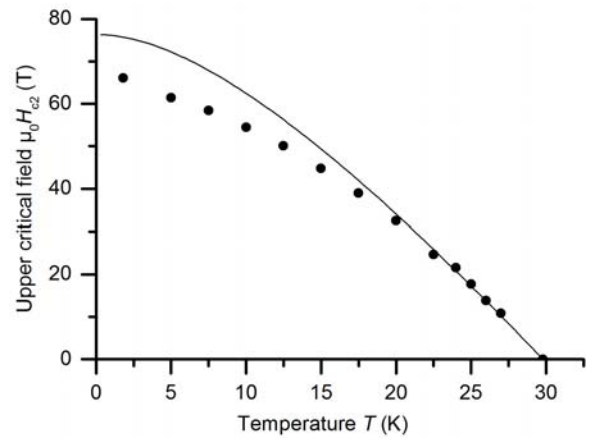

Figure: Temperature dependence of the upper critical field parallel to the crystallographic ab-planes for an optimally P-doped Ba-122 thin film with Fe deficiency. The dependency without paramagnetic limitation is shown for comparison.

Experimental

The upper critical fields of two P-doped Ba-122 thin film samples of similar stoichiometry have been determined on magnetic field-resistance curves for the two major directions, B||ab and B||c. The measurements have been performed in pulsed magnetic fields up to 65 T (NHMFL LANL).

Results and Discussion

The Figure shows exemplarily the temperature dependence of the upper critical field $\mu 0 H_{c2}$ for H||ab for an optimally P-doped sample with slight Fe deficiency [$BaFe_{1.83}(As_{0.71}P_{0.29})_{2.11}$]. This sample with x = 0.29 shows the optimum critical temperature T_c of around 30 K, suggesting that the superconducting dome is shifted to lower P-content for thin film samples (optimum T_c is reached for x = 0.35 for single crystals). At low temperatures, H_{c2} seems to be slightly paramagnetically limited, however not as strongly as expected from previous measurements up to 45 T. The exact influence of Fe stoichiometry and thin film geometry on H_{c2} will be determined in a careful data analysis and a comparison to H_{c2} data of other samples, measured at the pulsed field facility HZDR Rossendorf and to be measured at NHMFL LANL.

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