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Anisotropic upper critical fields up to 63 T in $CaKFe_4As_4$ single crystals

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Introduction

The discovery of Fe-based superconductors (FBS) has intensified research on mechanisms of high-temperature superconductivity as well as searches for materials with higher superconducting transition temperatures, T_c. Among many different classes of FBS, the so called "122" family is one of the most well studied systems. However, superconductivity in "122" systems is often stabilized via chemical substitution, which inevitably invites chemical disorder. Recently, a new compound, $CaKFe_4As_4$, with a well ordered structure that is essentially composed of alternating "122" layers, was discovered with a T_c of 35 K [1]. We were able to perform the first single crystal study and measured the anisotropic upper critical fields, H_{c2}, up to 63 T [2].

Experimental

$CaKFe_4As_4$ single crystals were grown using a high-temperature solution growth method [2]. Anisotropic upper critical fields were determined via resistive measurements using the standard 4-probe technique. High field data were obtained in a 65 T pulsed magnet at the National High Magnetic Field Laboratory (NHMFL), Los Alamos, using a high-frequency, synchronous digital lock-in technique (f = 148 kHz)

Results and Conclusion

Experimental data measured at NHMFL are shown in **Fig. 1** and the combined $H_{c2}(T)$ is shown in **Fig. 2**. Our results show that $H_{c2}(T)$ is controlled by interplay of orbital and paramangentic effects which cause the anisotropy parameter $\gamma(T) = H_{c2}^{\perp}/H_{c2}^{\parallel}$ to decrease as the temperature decreases. Despite the fact that Ca and K occupy different sites in $CaKFe_4As_4$ as opposed to solid solutions in $(Ba,K)Fe_2As_2$, the behavior $H_{c2}(T)$ turns out to be similar to that of the optimal doped $(Ba,K)Fe_2As_2$. $H_{c2}^{\perp}(0)$ could be extrapolated to ~ 92 T, well above the BCS paramagnetic limit. Higher fields are needed to reveal more details about the physics of $CaKFe_4As_4$.

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References

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[2] Meier, W.R., *et al.*, Phys. Rev. B, **94**, 064501 (2016).

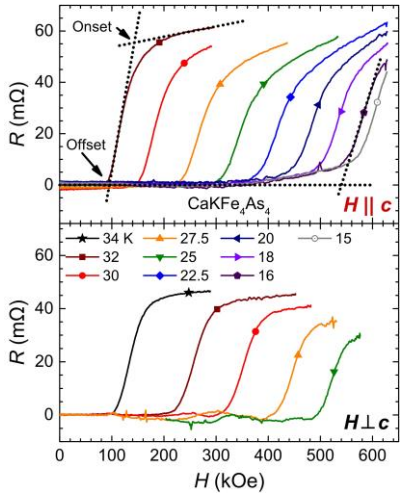

Fig. 1 Anisotropic, field-dependent resistance at various temperatures. Dotted lines and arrows indicate criteria for determining H_{c2}.

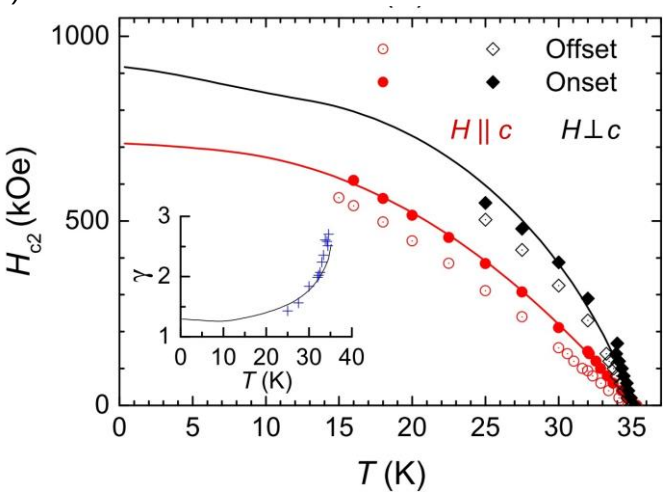

Fig.2 Anisotropic $H_{c2}(T)$ of $CaKFe_4As_4$. The inset shows the anisotropic parameter, $\gamma = H_{c2}^{\perp}/H_{c2}^{\parallel}$. Solid lines are theoretical fits.