Upper Critical Field Measurements of Heavy-Ion Irradiated P-doped $SrFe_2As_2$

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Introduction

The temperature and angular dependencies of the upper critical field, H_{c2}, contain information about the superconducting gap structure. We studied the H_{c2} in single crystals of clean iron-based superconductor $SrFe_2(As_{0.65}P_{0.35})_2$ with isoelectronic phosphorus substitution, reported to have nodal superconducting gap at the optimal doping [1]. By using heavy-ion irradiation we also study effects of elevated scattering on H_{c2}.

Experimental

H_{c2} measurements were conducted in pulsed magnetic fields using a tunnel-diode resonator in single crystals of pristine and heavy-ion (1.4 GeV $^{208}Pb^{56+}$) irradiated samples, with very high irradiation dose corresponding to the matching field B_φ = 25 T. The measurements were conducted in configurations with magnetic fields applied parallel to the *c*-axis and to the *ab*-plane of the samples.

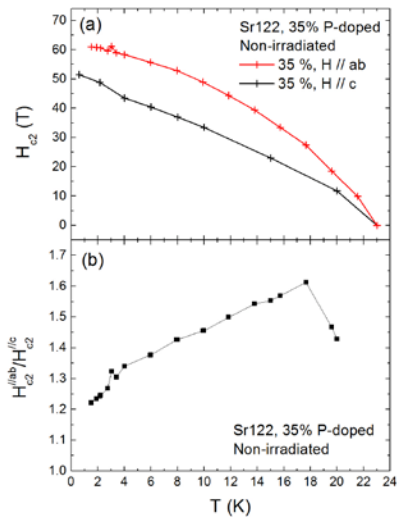

Figure 1. (a) $H_{c2}(T)$ and (b) anisotropy parameter γ(T) for pristine sample.

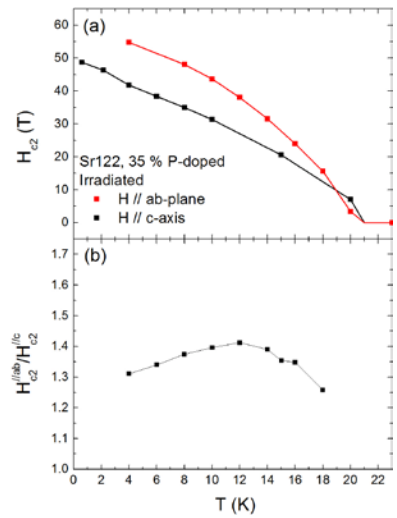

Figure 2. (a) $H_{c2}(T)$ and (b) anisotropy parameter γ(T) for irradiated sample.

Results and Discussion

Top panels in **Figures 1 and 2** show the $H_{c2}(T)$ for two principal directions of a magnetic field, bottom panels show temperature dependence of the anisotropy parameter $\gamma = H_{c2}^{H\|ab}/H_{c2}^{H\|c}$ for pristine and irradiated samples of $SrFe_2(As_{0.65}P_{0.35})_2$. The zero-field superconducting transition temperatures, T_c, for the non-irradiated and irradiated samples were determined to be T_c = 23.1 K and T_c = 22.6 K, respectively. Both samples show very similar $H_{c2}(T)$ temperature dependence in both configurations of a magnetic field (see **Figure 3** for direct comparison), resulting in a gradual decrease of anisotropy on cooling. The data suggest that $H_{c2}(T)$ in nodal Fe-based superconductors is different from that in full gap materials.

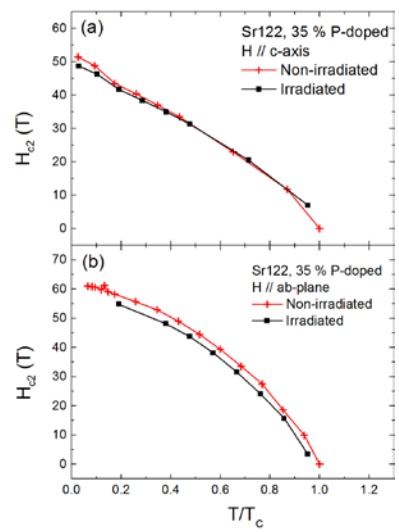

Figure 3. Comparison of H_{c2} for pristine and irradiated samples vs reduced temperature.

Conclusions

Studied samples show different shape of $H_{c2}(T)$ for two orientations of a magnetic field, yet different from full – gap pnictides. Irradiation of $SrFe_2(As_{0.65}P_{0.35})_2$ results in a uniform shift of $H_{c2}(T)$ without affecting its functional form.

Acknowledgements

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References

[1] Hideyuki Takahashi, Tatsunori Okada, Yoshinori Imai, Kentaro Kitagawa, Kazuyuki Matsubayashi, Yoshiya Uwatoko, Atsutaka Maeda, Phys. Rev. B. 86,144525 (2012)