

Lower critical field in the two-band superconductor $\text{LaRu}_4\text{As}_{12}$

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The filled skutterudite compound $\text{LaRu}_4\text{As}_{12}$ displays several features which point at a non-singlet superconducting order parameter ($T_c = 10.4$ K) [1], although the cubic crystal structure does not favor the emergence of multiple energy gaps. Here, we present results of a comparative study of the lower critical field (H_{c1}) for $\text{LaRu}_4\text{As}_{12}$ and the one-band BCS superconductors $\text{LaOs}_4\text{As}_{12}$ ($T_c = 3.2$ K) and $\text{PrRu}_4\text{As}_{12}$ ($T_c = 2.3$ K). The $H_{c1}(T)$ dependences were determined utilizing miniaturized 2DEG Hall sensors. Exceptionally for $\text{LaRu}_4\text{As}_{12}$, we have observed a pronounced enhancement of $H_{c1}(T)$ below $T/T_c \approx 0.35$. Since such enhancement is absent in the closely related superconductors down to $T/T_c \approx 0.1$, anisotropy effects must be of minor significance. Furthermore, a sharp kink in the $H_{c1}(T)$ behavior correlates with anomalies in the penetration depth [2]. Apparently, these findings reflect a faster drop of the superfluid density at low temperatures due to different contributions from two bands. Our results indicate that $H_{c1}(T)$ is a very useful tool to investigate multiband superconductivity.

References:

[1] Ł. Bochenek, *et al.*, Phys. Rev. B 86 (2012) 060511(R).

[2] T. Shibauchi *et al.*, private communication.