Superconducting Gap Symmetry for $BaFe_{1.8}Co_{0.2}As_2$ Superconductor

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To clarify the gap structure of the iron-pnictide superconductors, we synthesized optimally doped single crystals of $BaFe_{1.8}Co_{0.2}As_2$, which had a critical temperature, T_c, of 23.6 K, by using the self flux method. The initial M-H curve was used to find the lower critical field, H_{c1}, which was extracted from the point of deviation from Meissner linearity in this curve. H_{c1} showed a saturation behavior at temperatures below 3.5 K, which indicated s-wave gap symmetry at low temperatures. The in-plane penetration depth was estimated to be 169 nm, and the super-fluid density deviated from the Uemura relation. In addition to this, the full range of the temperature dependence of H_{c1} was explained by using a multi-gap structure, especially two s-wave gap symmetry. We estimate the magnitude of the two gap as $\Delta_1(0) = 1.37 \pm 0.2$ meV for the small gap and $\Delta_2(0) = 3.84 \pm 0.2$ meV for the large gap.

Keywords: Gap symmetry, FeAs superconductor, Uemura relation