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Gallium substitution in the transuranium superconductor PuCoGa₅

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Abstract

We have studied the effects of substituting gallium by aluminum, germanium, tin and indium in PuCoGa₅, the actinide-based superconductor with the highest critical temperature. By annealing arc-melted samples, we have been able to synthesize only compounds with 20% substitution by Al and Ge (i.e. PuCoGa₄Al and PuCoGa₄Ge). Refinements of X-ray powder diffraction patterns for these two compounds indicate an enhanced *c/a* ratio, whereas magnetic susceptibility measurements reveal a large reduction of the critical temperature T_c compared to PuCoGa₅. DFT+ED calculations indicate that the decrease of T_c is accompanied by significant changes in the Fermi surface. Finally, measurements on PuCoGa₅ samples made by using ⁶⁹Ga and ⁷¹Ga isotopes showed no effect of the atomic mass of gallium on the superconducting critical temperature.

Keywords: actinide alloys and compounds, intermetallics, superconductors, X-ray diffraction, magnetic measurements, electronic properties

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