Superconductivity in PrRu₄As₁₂ single crystals

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University of California San Diego — Single crystals of the filled skutterudite compound PrRu₄As₁₂ were characterized by magnetization, specific heat, and electrical resistivity measurements. These measurements reveal the occurrence of superconductivity below \(\sim 2.4\) K. The magnetic susceptibility exhibits behavior consistent with a Pr\(^{3+}\) ninefold degenerate \(J = 4\) Hund’s rule ground state multiplet split in a tetrahedral crystalline electric field with either a nonmagnetic singlet or doublet ground state. Fits to the specific heat data indicate an electronic contribution to the specific heat \(\gamma\) of \(\sim 70\) mJ/mol K\(^2\) and a Debye temperature \(\Theta_D\) of \(\sim 344\) K. The value of \(\Delta C/\gamma T_c \approx 1.53\) for PrRu₄As₁₂ is close to the weak-coupling BCS value of 1.43. Electrical resistivity measurements in field were used to determine \(H_{c2}\) as a function of temperature from which the zero temperature value of the orbital critical field \(^*H_{c2}(0)\) was calculated and used to estimate the coherence length \(\xi_0\) of PrRu₄As₁₂. In contrast to PrRu₄As₁₂, the compound PrOs₄As₁₂ displays two phase transitions at 2.2 K and 2.3 K in zero field, one of which is antiferromagnetic and the nature of the other is yet to be determined. PrOs₄As₁₂ also displays heavy fermion behavior with an enhanced electronic specific heat coefficient \(\gamma\) on the order of 200 mJ/mol K\(^2\) and a \(\Theta_D\) of only 260 K. This research was supported by the U.S. DOE (No. DE-FG02-04ER46105) and NSF (No. DMR 0335173).

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