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Magnetic properties in UFe_4P_{12} and single crystal growth of thorium compound

T.D. Matsuda[1], Y. Haga[1], A. Galatanu[1], T. Takeuchi[2], S. Ikeda[1,3], K. Sugiyama[4], M. Hedo[5], Y. Uwatoko[5], R. Settai[3] and Y. Ōnuki[1,3]

[1]ASRC, JAERI, Tokai, Ibaraki 319-1195
[2]Low Temperature Center, Osaka University, Toyonaka, Osaka 560-0043
[3]Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043
[4]Res. Cent. for Mater. Sci. at Extreme Conditions, Osaka Univ., Osaka 560-0043
[5]ISSP, University of Tokyo, Kashiwa, Chiba 277-8581

Among the various filled skutterudites crystallizing in $Im\bar{3}$ cubic structure, Pr-based systems have attracted much attention due to their unusual behavior[1,2]. Studies of these Pr-based filled skutterudites systems have revealed the nature of strongly correlated electron state based on the f^2 configuration. For a systematic understanding of strongly correlated electron states in this configuration, we have started the investigation of uranium-filled skutterudite.

UFe_4P_{12} shows a ferromagnetic ordering with the low Curie temperature $T_C = 3.15$ K, as previously reported[3]. We have succeeded in growing single crystal of UFe_4P_{12} and measured the electrical resistivity, specific heat, magnetic susceptibility, and high-field magnetization[4]. The experimental results have been analyzed on the basis of the crystalline electric field (CEF) model for the cubic symmetry of T_h point group. Possible CEF schemes to explain the experimental results, especially the inverse magnetic susceptibility at high temperatures up to 800 K and the magnetization in magnetic field up to 50 T, are proposed. The $5f^2$-CEF schemes of the Γ_1 ground state and the $\Gamma_4^{(2)}$ first excited state, separated by 6 K, and also the $\Gamma_4^{(2)}$ ground state and the Γ_{23} first excited state, separated by 800 K, explain well the overall magnetic property on UFe_4P_{12}. From these analyses, the characteristic term $O_6^2 - O_6^6$ in the CEF Hamiltonian for T_h site symmetry was found to be essentially important to explain the small saturation moment of 1.3 μ_B/U in UFe_4P_{12}.

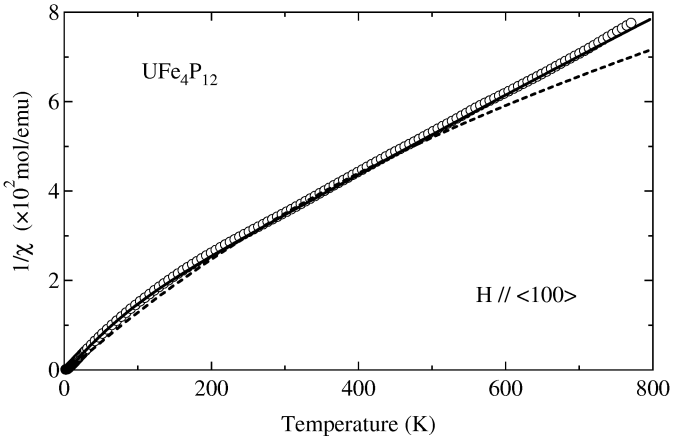

Figure 1: Reciprocal magnetic susceptibility for UFe_4P_{12}. The dashed and solid lines represent the results of the $5f^2$-CEF calculations. (see ref. [4])

[1] H. Sugawara *et al.*, Phys. Rev. B **66**, 220504 (2002) and references therein.
[2] E.D. Bauer *et al.*, Phys. Rev. B **65**, 100506R (2002).
[3] H. Nakotte *et al.*, Physica B **259-261**, 280 (1999) and references therein.
[4] T.D. Matsuda *et al.*, J. Phys. Soc. Jpn, **73**, 2533 (2004).