Specific Heat and Thermoelectric Power Studies of Filled Skutterudites Synthesized Under High-pressure

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We have systematically studied filled skutterudites RT_4X_{12} by specific heat and thermoelectric power measurements. In this meeting, we report and discuss the research results below.

(1) Novel properties in Sm-based filled skutterudites

The CEF states and Kondo temperature in SmT_4P$_{12}$ (T=Fe, Ru, Os) is estimated from the specific heat analysis [1]. Furthermore, we revealed that the *true* C/T of heavy fermion compound $SmOs_4Sb_{12}$ steeply increases below $T^\star \sim 20$ K without indicating a CEF effect [2].

(2) Novel phase transitions due to Fermi surface nesting in RRu$_4$P$_{12}$

RRu$_4$P$_{12}$ (R=Gd, Tb, Dy) shows a clear upturn in thermoelectric power at their phase transition temperatures, indicating a dramatic decreasing of carrier number due to Fermi surface nesting [3]. Furthermore, we revealed the novel phase diagram in TbRu$_4$P$_{12}$ (T_N=20K) with multi phases [4]. Interestingly, the T_N is not sensitive to a magnetic field in comparison with the case of GdRu$_4$P$_{12}$ (T_N=22K) . As the ordered state is strong against magnetic field, the ordered states in TbRu$_4$P$_{12}$ are speculated to be related to a multipole order [5].

(3) Low energy guest-mode of filled skutterudites

For La-based filled skutterudites, we can make a rough estimate of the phonon spectrum in low-energy region from the lattice specific heat. All La-based compounds have a large broad maximum in $(C-\gamma T)/T^3$ characterized by Einstein specific heat, suggesting a nearly dispersionless low-energy optical mode. In filled skutterudites, the low-energy optical modes are associated with the modes including R ions in the X_{12}-cage. The energy of low-lying guest mode is estimated from the broad peak in $(C-\gamma T)/T^3$ ($T_{max} \sim \Theta_E/4.9$). Figure 1 shows the guest free distance r_{GF} dependence of Einstein temperature Θ_E: $r_{GF} \equiv r_{R-X} - r_{La^{3+}} - r_X$, where r_{R-X} is the distance between R and X, $r_{La^{3+}}$ is the effective ionic radius of La^{3+} with coordination number 12 and r_X is the covalent radius of X. We discuss the correlation between the energy of low-lying guest mode and the structural parameter.

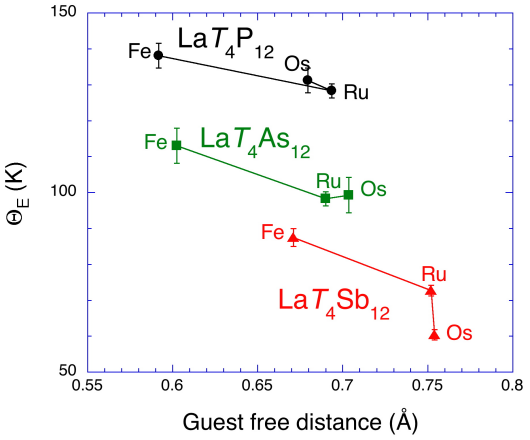

Figure 1: Guest free distance dependence of Einstein temperature Θ_E for LaT_4X_{12}.

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