

(P1-11)

Magnetic and Thermoelectric Properties of $\text{LaT}_4\text{Sb}_{12}$ ($T = \text{Fe, Ru, Os}$)

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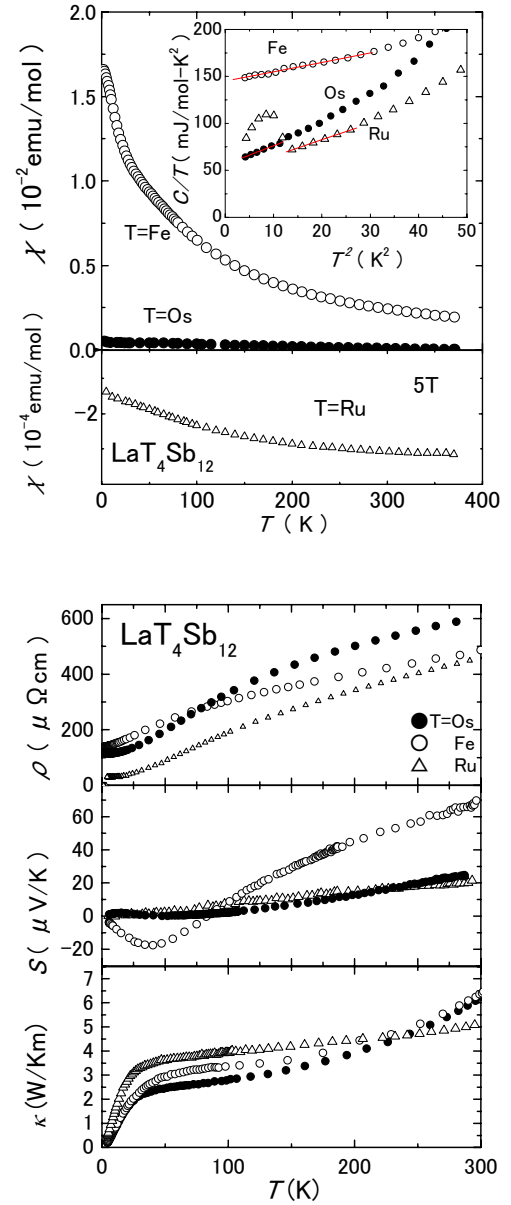
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Our previous studies of alkaline-earth-filled skutterudites $\text{AT}_4\text{Sb}_{12}$ ($T = \text{Fe, Ru, Os}$) revealed that the magnetic properties strongly depend on the T element [1,2]. A nearly ferromagnetic metal for $T = \text{Fe}$ changes to an enhanced Pauli paramagnet for $T = \text{Os}$, and a diamagnetic metal for $T = \text{Ru}$. Among these compounds, the thermal conductivity for $T = \text{Os}$ is largely suppressed and does not show a peak at low temperatures [2]. In order to understand the origin of these trends in alkaline-earth filled systems, we have studied the magnetic and thermoelectric properties of $\text{LaT}_4\text{Sb}_{12}$ ($T = \text{Fe, Ru, Os}$), which are free from the complexity due to $4f$ electrons.

Dense polycrystalline samples were prepared by spark-plasma-sintering [1]. The filling fractions of La are 0.88, 0.95, and 0.98, respectively, for $T = \text{Fe, Ru, Os}$. We measured the magnetic susceptibility χ , electrical resistivity ρ , thermal conductivity κ , thermopower S , and specific heat C . The temperature dependences are shown in the figures. As similar to the case of $A = \text{divalent Ca, Sr, and Ba ions}$, the magnetism of the systems with trivalent La ions changes from the Curie-Weiss paramagnetic metal for $T = \text{Fe}$ to a Pauli paramagnetic metal for $T = \text{Os}$, and a diamagnetic metal for $T = \text{Ru}$. Along with this change, the electronic specific heat coefficient decreases from 145 to 53, and 48 $\text{mJ/K}^2\text{mol}$. For $T = \text{Fe and Os}$, $\rho(T)$ has a shoulder at 50 K and 100 K, respectively. $S(T)$ for $T = \text{Fe}$ exhibits a negative minimum at 50 K and increases up to 70 $\mu\text{V/K}$ with increasing temperature, whereas $S(T)$ for $T = \text{Ru and Os}$ is smaller than that for $T = \text{Fe}$ and monotonically increases. It is remarkable that $\kappa(T)$ of $\text{LaT}_4\text{Sb}_{12}$ does not show any peak at low temperatures for all $T = \text{Fe, Ru, and Os}$.

Recalling that the ionic radius of La^{3+} is smaller than that of A^{2+} , the absence of the peak in $\kappa(T)$ is attributed to the phonon scattering by rattling of La^{3+} ions in the oversized cage of T_4Sb_{12} [3]. For $T = \text{Fe}$, the scattering by the La defects should also play a role.



[1] E. Matsuoka *et al.*, J. Phys. Soc. Jpn. 74 (2005) 1382.

[2] E. Matsuoka *et al.*, J. Phys. Soc. Jpn. 75 (2006) 014602.

[3] T. Takabatake *et al.*, Physica B (2006) in press.