

(PS14)

Thermoelectric properties of alkaline-earth filled skutterudite compounds AT_4Sb_{12} (A=Ca, Sr, Ba, T=Fe, Ru)

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The filled-skutterudite compounds continue to be of great interest not only for the unusual physical properties but also for thermoelectric application [1]. Compared with rare-earth filled families, much less are known for the alkaline-earth filled families. Therefore, we have prepared high-density polycrystal samples of AT_4Sb_{12} (A=Ca, Sr, Ba, T=Fe, Ru) by the spark plasma sintering method, and measured magnetic susceptibility χ , thermopower S , resistivity ρ , thermal conductivity κ , and specific heat C [2].

The temperature dependence of χ^{-1} for AT_4Sb_{12} is shown in Fig. 1. The Curie-Weiss behavior above 200 K gives an effective moment of about $1.5 \mu_B/\text{Fe-atom}$ for the three Fe compounds with A=Ca, Sr, and Ba. The paramagnetic Curie temperature θ_p increases from 14 K for A=Ba to 54 K for A=Ca. This systematic increase in θ_p indicates that the ferromagnetic interaction of $3d$ band becomes stronger on decreasing the size of A ion. On the other hand, ARu_4Sb_{12} (A=Sr, Ba) shows diamagnetism. Thus, $4d$ electrons of the Ru compounds carry no magnetic moment.

The temperature dependence of S is shown in Fig. 2. For AFe_4Sb_{12} , $S(T)$ has a shoulder at about 50 K and increases to a large value of $100 \mu\text{V}/\text{K}$ at 500 K. On the other hand, $S(T)$ for ARu_4Sb_{12} exhibits a positive maximum at 30 K and a negative minimum at 120 K. This sign change suggests the presence of two or more kinds of carrier in the Ru compounds.

The electronic specific heat coefficients γ for AFe_4Sb_{12} are approximately $100 \text{ mJ}/\text{mol K}^2$. This reflects the high density of states derived from the Fe atoms. The low value of $10 \text{ mJ}/\text{mol K}^2$ for the Ru compounds is consistent with the diamagnetic susceptibility.

The highest thermoelectric figure of merit ZT for the studied families of AT_4Sb_{12} is 0.05 at 300 K for $SrFe_4Sb_{12}$, being one fourth of the best value reported for $Ce_{0.9}Fe_3CoSb_{12}$ [1].

[1] B.C. Sales et al., Phys. Rev. B **56**, (1997) 15081.

[2] E. Matsuoka et al., 28a3 this meeting.

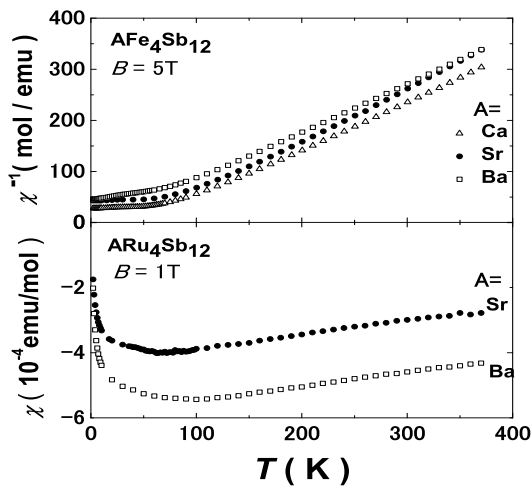


Fig. 1

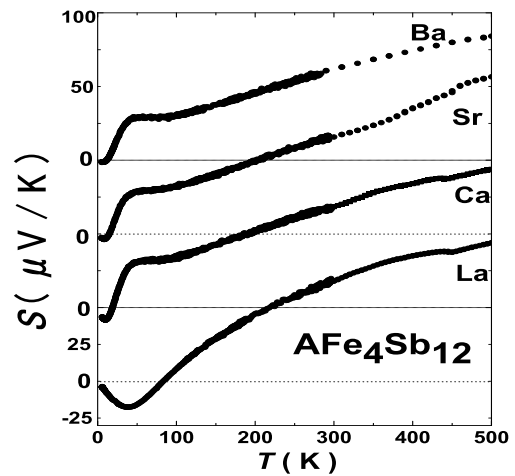


Fig. 2