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Thermal expansion of CeRhSb under high pressure

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Abstract

The linear thermal expansion of polycrystalline CeRhSb has been measured in the temperature range $77 \text{ K} < T < 300 \text{ K}$ under hydrostatic pressure up to 2.3 GPa. It is found that the thermal expansion coefficient $\alpha(T)$ at ambient pressure shows a maximum around $T_{\text{max}} = 140 \text{ K}$ and T_{max} increases with increasing pressure having rate of $\partial T_{\text{max}}/\partial P = + 38.5 \text{ K/GPa}$. This fact shows that the Kondo temperature T_K is increased by applying pressure.

Keywords: CeRhSb; Thermal expansion; High pressure

CeRhSb is a mixed-valent compound and a rare prototype of Ce compound which shows semiconducting properties with a small energy gap $\sim 8 \text{ K}$ at the Fermi level at low temperatures [1]. This anomalous electronic structure is considered to arise from strong hybridization between magnetic 4f electrons and conduction electrons [1].

In this work, we attempt to measure the thermal expansion of polycrystalline CeRhSb under high pressure in order to get the information of the origin of the anomalous electronic structure in this compound.

Polycrystals of CeRhSb were prepared by arc melting high purity constituents in an argon atmosphere and annealed at 900°C for a week. Thermal expansion was measured in the temperature range of $77 \leq T \leq 300 \text{ K}$ by using a strain gauge method [2]. Hydrostatic pressure up to 2.3 GPa was generated by using a piston-cylinder device and a 1:1

mixture of fluorinert FC70 and FC77 as a pressure transmitting medium.

Fig. 1 shows the temperature dependence of magnetic contribution to the linear thermal expansion coefficient $\alpha_{\text{mag}}(T)$ of CeRhSb under high pressure. $\alpha_{\text{mag}}(T)$ is estimated by subtracting $\alpha(T)$ of LaRhSb at ambient pressure from $\alpha(T)$ of CeRhSb. LaRhSb is non-magnetic and exhibits a conventional temperature dependence, i.e., the contribution from phonons. As temperature increases, $\alpha_{\text{mag}}(T)$ at ambient pressure shows a shoulder around 20 K and exhibits a broad maximum around $T_{\text{max}} = 140 \text{ K}$, where the electrical resistivity also shows a maximum [1]. This feature is due to both Kondo effect and crystalline field effect as is seen in several Ce-based compounds [3]. T_{max} is found to increase with increasing pressure. In addition, the value of α_{mag} at T_{max} increases and the maximum becomes broader as pressure increases. The former result is interpreted as the enhancement of Kondo temperature T_K by applying pressure and the latter due to the increase of crystalline field splitting.

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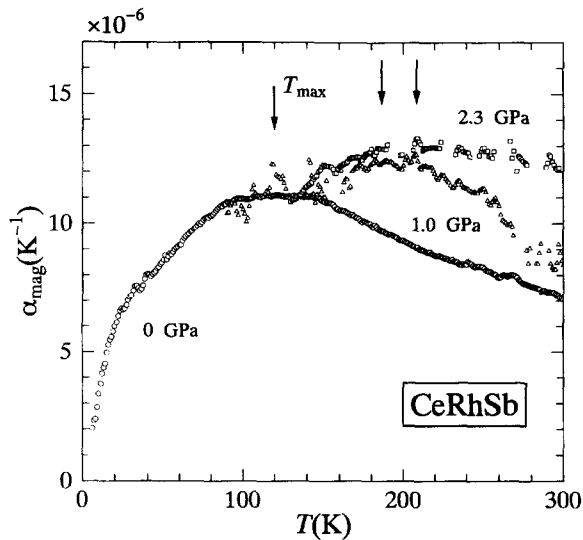


Fig. 1. Temperature dependence of magnetic contribution to linear thermal expansion coefficient $\alpha_{\text{mag}}(T)$ of CeRhSb under high pressure. T_{max} where $\alpha_{\text{mag}}(T)$ shows a broad maximum is shown by arrows.

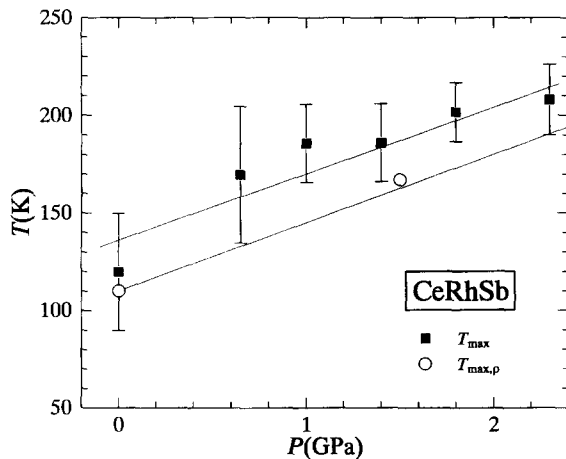


Fig. 2. Pressure dependence of T_{max} (close square) and $T_{\text{max},\rho}$ (open circle), where $\rho(T)$ curve shows a maximum (see in Ref. [4]).

Pressure dependence of T_{max} is shown in Fig. 2. T_{max} increases with increasing pressure having a rate of $dT_{\text{max}}/dP = +34 \text{ K/GPa}$. The pressure dependent $T_{\text{max},\rho}$, where $\rho(T)$ curve shows a maximum, is also shown by the open square [4]. $T_{\text{max},\rho}$ increases with pressure with a rate of $dT_{\text{max},\rho}/dP = +35 \text{ K/GPa}$. The slope of T_{max} is in good agreement with that of $T_{\text{max},\rho}$. This fact indicates that the maxima of α_{mag} and ρ arise from the same origin, i.e., Kondo effect with crystalline field splitting.

In conclusion, we measured the thermal expansion of CeRhSb under high pressure. T_{max} increases with increasing pressure having a rate of $dT_{\text{max}}/dP = +35 \text{ K/GPa}$, which reflects the enhancement of T_{K} under high pressure.

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