Supporting Information

Superconductivity in $CaSn_3$ single crystal with a $AuCu_3$-type structure

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Abstract

We report the superconductivity of the $CaSn_3$ single crystal with a $AuCu_3$-type structure, namely cubic space group $P_{m\bar{3}m}$. The superconducting transition temperature T_C=4.2 K is determined by the magnetic susceptibility, electrical resistivity, and heat capacity measurements. The magnetization versus magnetic field (*M-H*) curve at low temperatures shows the typical-II superconducting behavior. The estimated lower and upper critical fields are about 125 Oe and 1.79 T, respectively. The penetration depth $\lambda(0)$ and coherence length $\xi(0)$ are calculated to be approximately 1147 nm and 136 nm by the Ginzburg-Landau equations. The estimated Sommerfeld coefficient of the normal state γ_N is about 2.9 mJ/mol K^2. $\Delta C/\gamma_N T_C$ =1.13 and λ_{ep}=0.65 suggest that $CaSn_3$ single crystal is a weakly coupled superconductor. Electronic band structure calculations show a complex multi-sheet Fermi surface formed by three bands and a low density of states (DOS) at the Fermi level, which is consistent with the experimental results. Based on the analysis of electron phonon coupling of AX_3 compounds (A=Ca, La, and Y; X=Sn and Pb), we theoretically proposed a way to increase T_C in the system.

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More experimental details:

The used crystals were cubic or rectangle shape, we decanted the crystals is about 270 °C, which is higher than the melting point of element Sn (231 °C) and decanting speed is very fast and can reach 1800 round/second within 10 seconds. We did the polishing before doing the measurements, so just little element Sn may be left on the surface.

Figures:

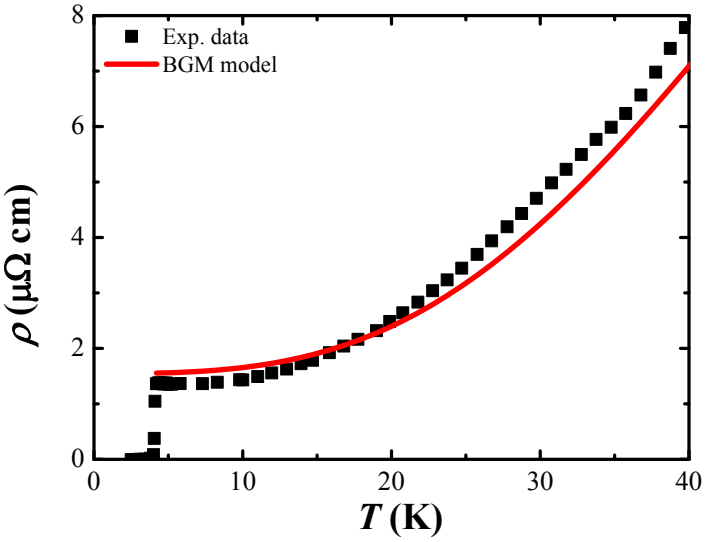

Fig. S1: The fitting result using the BGM model is shown at the low temperature.

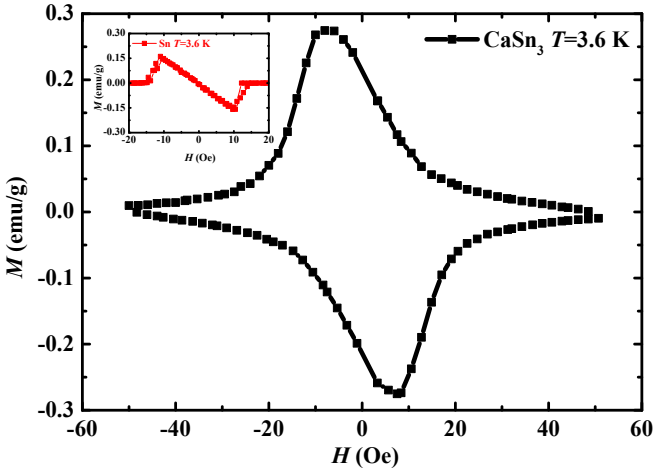

Fig. S2: The comparation of *M(H)* between the $CaSn_3$ single crystal and element Sn at *T*=3.6 K.