$SnSb_2Te_4$における圧力誘起超伝導

Pressure-induced superconductivity in $SnSb_2Te_4$

宋 鵬[1, 2], 松本 凌[1, 2], Hou Zhufeng[1], 足立 伸太郎[1], 原 裕[1, 2], 齋藤 嘉人[1, 2],
P. B. Castro[1,2], 竹屋 浩幸[1], 高野 義彦[1, 2]
(1. 物材機構, 2. 筑波大)

Peng Song[1, 2], Ryo Matsumoto[1, 2], Zhufeng Hou[1], Shintaro Adachi[1], , Hiroshi Hara[1, 2],
Yoshito Saito[1, 2], P. B. Castro[1,2], Hiroyuki Takeya[1], Yoshihiko Takano[1, 2]
(1. NIMS, 2. Univ. of Tsukuba,)

BCS theory is one of the main theories of superconductivity. It predicts a relationship between the superconducting transition temperature T_c, Debye temperature θ_D, and electron density of state $D(\varepsilon_f)$ at the Fermi surface and the electron-phonon interaction U, which can be estimated from the electrical resistivity. For the $U\,D(\varepsilon_f) << 1$, according to BCS theory, Tc is given by: $T_c = 1.14\theta_D/(-1/\,U\,D(\varepsilon_f))$. In this case, by modifying the electronic density of states (DOS) at the Fermi level, it is possible to tune in the system into a superconducting state. Materials with narrow band gap can be easily tuned into a metallic state by applying pressure which in turn increase the density of state near the Fermi level. By searching a material database, we've selected a candidate material, $SnSb_2Te_4$, which is semiconductor with a narrow band gap of 0.259eV, calculated using Quantum Espresso 6.3. We supposed that $SnSb_2Te_4$ will exhibit superconductivity for the purpose of experimentation. In this study we report the discovery of a new superconducting phase in $SnSb_2Te_4$ at high pressure. Our study of the superconducting transition temperature evolution with pressure, shows a gradual increase of T_c with the applied pressure.

The single crystal of the $SnSb_2Te_4$ were grown using a conventional melting-growth method. The resistance under pressure of the sample was measured using an originally designed diamond anvil cell with Boron-doped diamond electrodes[1]. Figure 1 shows the thermal evolution of the resistance for $SnSb_2Te_4$ under ambient and pressures between 6.3 GPa and 32.6 GPa. At ambient pressure, the sample exhibited metallic behavior, differing from theoretical calculation. The superconducting transition appeared at 2.1 K(T_c^{onset}) under 8.1 GPa, which was further increased with applied pressure.

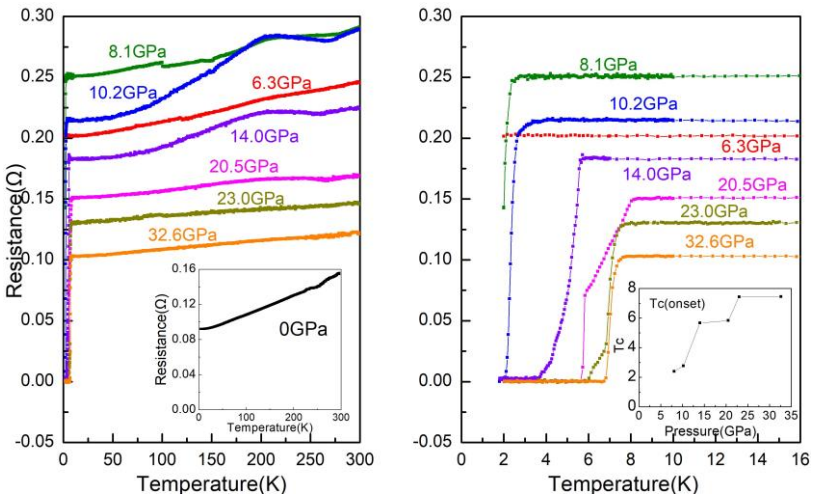

Fig. 1. Temperature dependence of the resistance in the $SnSb_2Te_4$

[1] R. Matsumoto et al., Rev. Sci. Instrum. 87, 076103 (2016)