Thermoelectric Properties of Paracostibite Fabricated using Chemically Synthesized Co–Sb–S Nanoparticles as Building Blocks

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Paracostibite (CoSbS) is regarded as a promising candidate for n-type thermoelectric materials owing to its characteristic band structure. Many researchers have investigated its thermoelectric (TE) properties, however, electrical properties of CoSbS were different and controvertial.[1] For example, different groups reported the existence of either an acceptor level[2] or a donner level.[3] The performance of TE properties is evaluated by dimensionless figure of merit: $ZT = \sigma S^2 T/\kappa$ (σ: electrical conductivity; S: Seebeck coefficient; T: Absolute temperature; κ: thermal conductivity). Doping or substitution for CoSbS was often conducted to increase ZT value.

In this study, we focused on the electrical properties of CoSbS. It is known that different fabrication processes of CoSbS might lead to formation of different defect levels in CoSbS, which would strongly influence the electrical transport properties. In this study we chemically synthesized Co-Sb-S nanoparticles (NPs) and the NPs were pelletized at high temperature to make a CoSbS pellet. The TE properties of the pellet showed that the highest σ and the lowest κ among the existing reports. The detailed analyses of electrical resistivity (Fig. 1a) revealed that the existence of donner levels. It was found that at low temperature (< 170 K) carrier transportation was governed by Mott-variable range hopping (E_a = 30 meV), while band conduction (E_a = 120 meV) became dominant at high temperature (300-661 K) as shown in Fig. 1b. As a result, the ZT value reached 0.05 at 661 K, which was within the reported value range.[1]

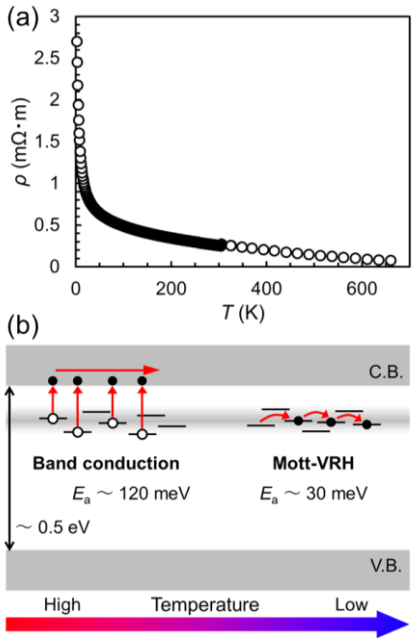

Fig. 1. (a) electrical resistivity of the CoSbS pellet. (b) Schematic illustration of the band structure and electrical transportation process.

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