

Hole Doping in Soluble Organic-Inorganic Hybrid Semiconductors of A_2SnI_4 (A = Organic Cation)

Yukari Takahashi, Yukihiro Takahashi, Tamotsu Inabe

Department of Chemistry, Graduate School of Science, Hokkaido University, Japan

Email: yukarin@mail.sci.hokudai.ac.jp

Tin-iodide layered perovskites are known to be soluble in organic solvents. The crystal is composed of alternating tin-iodide perovskite and organic cation layers (Fig. 1). The band structure calculation shows that there is a well-defined band gap (> 1 eV) between the valence band (mainly composed of Sn 5s and I 5p orbitals) and conduction band (mainly composed of Sn 5p orbital). However, the electrical conductivity within the inorganic layer was found to be rather high (Fig. 2). We attempted artificial hole doping by adding Sn^{4+} to the crystal growth solution of $(C_6H_5C_2H_4NH_3)_2SnI_4$. The room-temperature resistivity of the Sn^{4+} -doped crystal was found to be one or two orders of magnitude less than that of the as-grown crystal. Therefore, the high conductivity of as-grown crystal is considered to result from low levels of spontaneous p-type doping^[1].

It is considered that the acceptor levels are produced in all the A_2SnI_4 compounds, and the concentration of such levels may depend on the species of organic cations. For the efficient hole doping, organic dications are thought to be more preferable, and we have prepared $[NH_3(CH_2)_5NH_3]SnI_4$ and $[NH_3(CH_2)_4NH_3]SnI_4$ crystals from the ethanol solutions. The details of their crystal structures, the electrical properties, and the effects of the artificial hole doping about these crystals will be presented.

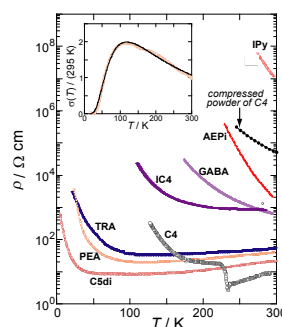
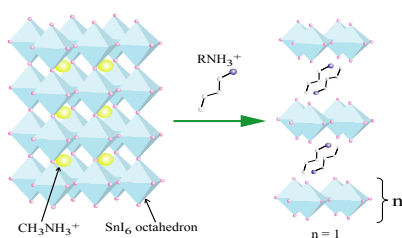


Fig. 1 Tin-iodide layered perovskite. Fig. 2 Electrical resistivities of A_2SnI_4 compounds.

[1] Y. Takahashi, R. Obara, K. Nakagawa, M. Nakano, J. Tokita and T. Inabe, Chem. Mater., 19 (2007) 6312.