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The investigation of magnetic properties on stannite by Mössbauer spectroscopy

Il Jin Park, In Bo Shim, Chul Sung Kim*

Department of Physics, Kookmin University, Jeongneung-dong, Seongbuk-gu, 136-702 Seoul, Korea
**cskim@kookmin.ac.kr*

Stannite (Cu_2FeSnS_4 or $Cu_2FeSnSe_4$) is one of the best-known chalcogenide materials, not only because of its economic importance as a tin ore, but also because of its scientific and technical interests. Moreover, stannites have newly attracted attention as possible photovoltaic materials. Chalcogenide-based photovoltaic material is one of the Indium free absorber materials for thin film solar cells [1]. A specific interest that bridges natural and materials sciences is related to the magnetic properties of stannites group; several questions in fact are still open. In this research, we investigate the structural and magnetic properties of $Cu_2FeSnSe_4$.

Stannite $Cu_2FeSnSe_4$ crystals are synthesized by solid-state reaction from the high purity elements in evacuated quartz ampoules. The crystal structure of $Cu_2FeSnSe_4$ was determined by the Rietveld refinement technique. The crystal structure of the sample at room temperature is determined to be a tetragonal structure with its lattice constants $a_0 = 5.69$ Å and $c_0 = 11.30$ Å. The magnetization measurements were carried out using MPMS quantum design superconducting quantum interference device (SQUID) magnetometer. We measured the temperature dependence of the magnetization from 5 to 300 K under applied magnetic field of 0.5 T. The magnetic Néel temperature (T_N), which is defined as temperature of the maximum slope in dM/dT, is determined to be 13 K. The magnetic behaviour shows antiferromagnetic characteristic. In order to study the change of the detailed local structure, we have obtained ^{57}Fe Mössbauer spectra at various temperatures.

[1] T. K. Todorov, K. B. Reuter, and D. B. Mitzi, *Adv. Mater.* **22**, 1 (2010).