

Silver and copper selenide: New approach in manufacture of highly efficient thermoelectric

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Abstract

The current interest in thermoelectric materials (TE) focuses on its ability to transform a temperature difference in a voltage difference (*Seebeck effect*). Similarly to the creation of a temperature difference due to an electric voltage (*Peltier effect*), it is possible to use them as heat sources and sinks in industrial applications as an alternative cooling medium and cooling. [1] The main advantages of thermoelectric devices over other cooling systems - *compression systems* - is a more reliable usage time by not having moving parts, non-use of greenhouse gases and the absence of vibration due they are solid state devices with reduced size becoming very efficient in local applications.

Increasing the efficiency of a thermoelectric material necessitates increasing the figure of merit, usually called zT . The zT is composed of three material's parameters as well as the absolute temperature T . $zT = (S^2 \sigma) \kappa^{-1}$ in which S is the Seebeck coefficient, σ is the electrical conductivity, and $\kappa = \kappa_e + \kappa_p$ is the thermal conductivity (κ_e and κ_p are the electron and phonon contributions respectively).[2] The TE performance is maximized by realizing excellent electrical transport and poor heat conduction in solid materials.

The n-type $Ag_{2+x}Se$ and p-type $Cu_{2+x}Se$ has promising thermoelectric properties. Previous investigations on Ag_2Se report that it has high electrical conductivity and low thermal conductivity and that it zT approaches 1 at room temperature. [3] The reported zT increases as temperature increases from 70 K to room temperature. This is especially encouraging because Ag_2Se becomes a superionic conductor around 407 K, as does Cu_2Se , which has been reported to have a zT that increases with temperature to 1.5 at 1000 K. [4] Report a new approach in manufacture of highly efficient thermoelectric via reactive sputtering. This new manufacturing technology allows to control the stoichiometry of the samples, the crystallographic orientation and thermoelectric properties. It is fully reproducible and scalable to the industry today. In **Figure 1** it is shown as morphology is influenced depending these stoichiometries changes.

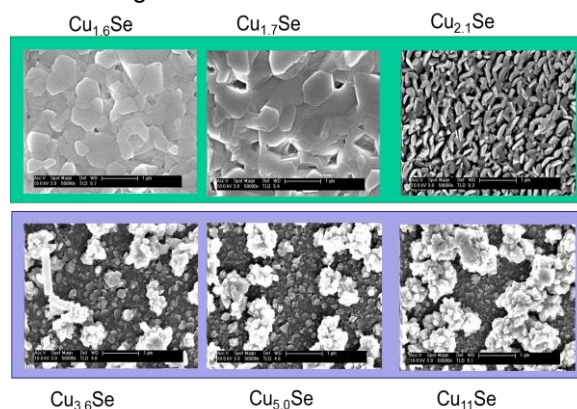


Figure 1. The low-Seebeck phase is composed of well-densified plate-like grains with sizes about a micron, while the high-Seebeck phase shows small grains of tenths-of-micron size.

References

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