Enhancement of Thermoelectric Performance in n-type PbTe$_{1-y}$Se$_y$ by Cr Doping

EYOB CHERE, QIAN ZHANG, Univ of Houston, KENNETH MCENANEY, MIT, MENG LIANG YAO, Boston College, FENG CAO, Univ of Houston, CYRIL OPEIL, Boston College, GANG CHEN, MIT, ZHIFENG REN, Univ of Houston — Lead telluride and its alloys have been extensively studied for medium temperature thermoelectric applications. However, little emphasis has been given to improve the figure-of-merit ($ZT$) near room temperature. In this investigation, we report a systematic study of Cr doping in PbTe$_{1-y}$Se$_y$ with $y = 0, 0.25, 0.5, 0.75, 0.85$, and $1$. We found the peak $ZT$ temperature increased with increasing concentration of Se. A highest $ZT$ of $\sim 0.6$ at room temperature in Te-rich Cr$_{0.015}$Pb$_{0.985}$Te$_{0.75}$Se$_{0.25}$ was obtained due to a lowered thermal conductivity and enhanced power factor resulted from high Seebeck coefficient of about $-220$ $\mu V$ K$^{-1}$ and high Hall mobility $\sim 1120$ cm$^2$ V$^{-1}$ s$^{-1}$ at room temperature. A room temperature $ZT$ of $\sim 0.5$ and peak $ZT$ of $\sim 1$ at about 573 K to 673 K is shown by Se-rich sample Cr$_{0.01}$Pb$_{0.99}$Te$_{0.25}$Se$_{0.75}$. This improvement of the room temperature $ZT$ improved the average $ZT$ over a wide temperature range and could potentially lead to a single leg efficiency of thermoelectric conversion for Te-rich Cr$_{0.015}$Pb$_{0.985}$Te$_{0.75}$Se$_{0.25}$ up to $\sim 11$ % and Se-rich Cr$_{0.01}$Pb$_{0.99}$Te$_{0.25}$Se$_{0.75}$ up to $\sim 13$ % with cold side and hot side temperature at 300 K and 873 K, respectively, if matched with appropriate p-type legs.

Eyob Chere
Univ of Houston

Date submitted: 13 Nov 2014