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Effect of Antimony-doping and Germanium on the Highly Efficient Thermoelectric Si-rich-$Mg_2(Si,Sn,Ge)$ Materials

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Abstract

Two series of materials (a) $Mg_2Si_{0.55-y}Sn_{0.4}Ge_{0.05}Sb_y$, $0 \leq y \leq 0.0175$ and (b) $Mg_2Si_{0.5875-x}Sn_{0.4}Ge_xSb_{0.0125}$, $0 \leq x \leq 0.20$ have been developed and studied in terms of structural features and thermoelectric properties/performance. The materials were prepared by a combination of low temperature reaction, ball milling process and hot pressing consolidation. Structure and composition across all relevant length scales was monitored by using XRD, SEM, TEM and HRTEM analysis and the influence of Sb-doping and Ge-addition on the phase structure and thermoelectric transport properties is presented. All different existing phases (Si-rich, Sn-rich and Ge-rich regions) contribute to the overall thermoelectric performance, having varying compositions in terms of the Bi dopant. Moreover, the coexistence of microstructural constituents and nanostructures formed in these materials is discussed explaining the enhancement of the TE behavior via the decrease of thermal conductivity.