Silicon and metal silicides nanocomposites as high-performance thermoelectric materials

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Abstract

Conventional thermoelectric (TE) materials such as Bi2Te3 and PbTe contain highly-toxic and rare elements. Therefore, high-performance TE materials made from non-toxic and Earth-abundant elements need to be developed. Our group has focused on Si and metal silicides nanocomposites for such advanced TE materials. Although Si exhibits excellent power factor, the $zT$ is not high as those of the conventional TE materials due to its high lattice thermal conductivity. When metal silicides disperse in the Si matrix in nanoscale, they scatter heat carrying phonons effectively, leading to enhancement in the $zT$ of Si. Moreover, additional effects such as modulation doping and energy filtering for further enhancement of the power factor can be expected under several systems between Si and specific metal silicides. Here, VSi2, Mg2Si, NiSi2, TiSi2, CoSi2, ... are selected as the metal silicides. We synthesized the Si and metal silicides nanocomposites by a melt spinning method. The melt spinning enables us to control the size and the distribution of the metal silicides. In the nanocomposites, the metal silicides exist as nano-precipitates in the Si matrix with nano-dot or nano-lamellar structure. The experimental results on the microstructure and TE properties of the nanocomposites will be presented. This work was supported in part by JST, PRESTO Grant Number JPMJPR15R1.

Keywords: silicon, metal silicide, nanocomposite

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