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High Thermoelectric Performance in *n*-type (Hf,Zr)NiSn Half-Heusler Alloys Through Metallic Nanoinclusions

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Abstract

Half-Heusler (hH) alloys are a promising thermoelectric material for energy harvesting applications in waste heat recovery system due to their exceptional thermal and mechanical stability and excellent electrical transport properties. However, a relatively high thermal conductivity (7-10 W/m-K) of hH alloys has been challenging in realizing good thermoelectric performance. Here we provide breakthrough in demonstrating high thermoelectric performance in *n*-type hH alloy through incorporation of tungsten nanoinclusions. The tungsten nanoparticles not only assist electron injection, thereby improving higher electrical conductivity, but also enhance Seebeck coefficient through energy filtering effect. This results in outstanding improvement in power factor. The microstructure comprises of multiple phases with feature sizes at different length scales, which provides effective scattering of heat-carrying phonons. Intrinsic properties of tungsten, such as lower specific heat capacity and large acoustic impedance difference with hH matrix are also found to contribute towards lower thermal conductivity. Cumulatively, these effects are shown to result in ultra-high thermoelectric performance of zT_{max} ~ 1.4 at 773K and zT_{avg} ~ 1.2 in the temperature range of 573-973K for n-type (Hf,Zr)NiSnSb compound with 5 wt% of tungsten inclusion.

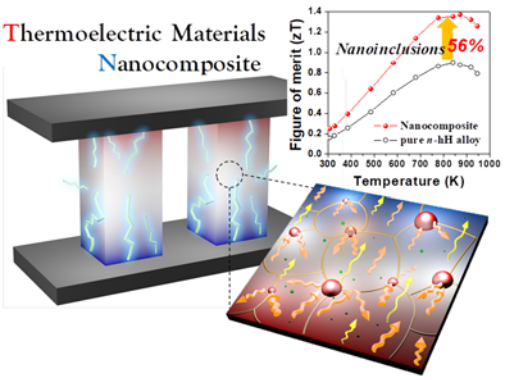

Figure. Schematic illustration of the effect of metallic inclusions on thermoelectric materials

Biography

Han Byul Kang is a Ph.D candidate in Materials Science and Engineering (MSE). He received his B.S. and M.S. degree in MSE from Yonsei University in South Korea, 2011 and 2014, respectively. He has been working in the Center for Energy Harvesting Materials and Systems (CEHMS) under the supervision of Dr. Shashank Priya since fall 2015. His current research focuses on nanostructured half-Heusler alloys for high temperature thermoelectric application in energy harvesting system.