Thermoelectric properties of W-substituted bulk higher manganese silicide

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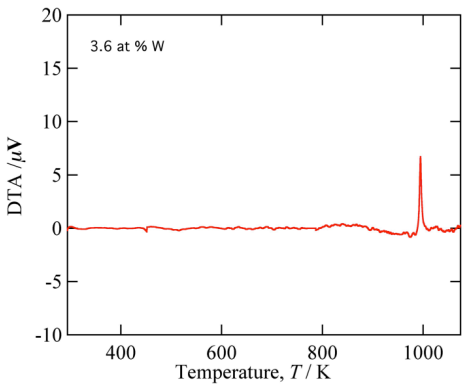
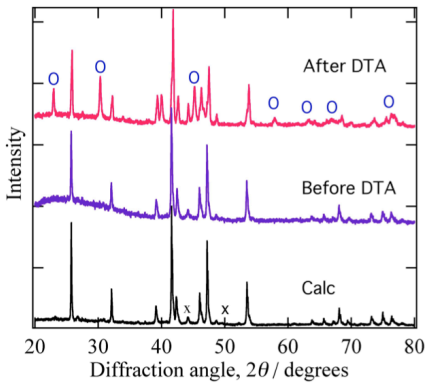
Abstract

The non-toxic and cost effective higher manganese silicide (HMS) is considered as an ideal material for commercial thermoelectric applications because of large Seebeck coefficient 200μVK^{-1}and metallic electrical connectivity 2 mΩcm. However, the magnitude of dimensionless figure of merit *ZT* is limited below 0.5, due to its large thermal conductivity of 3 Wm^{-1}K^{-1}. The heavy element substitution to reduce the lattice thermal conductivity is an effective technique to improve the ZT [1]. Here, in our study we have tried to reduce the lattice thermal conductivity of HMs by partial substitution of W for Mn without producing any impurity states.

We prepared ($Mn_{36.64-x}W_xSi_{63.36}$) by melting high purity Mn, Si, and W elements in arc-melting furnace followed by Liquid quenching technique, where the molten alloy was injected on a copper wheel of 200mm diameter and rotating at ~4500 rpm. All the above processes were carried out under pressurized Argon atmosphere.

The powder XRD data confirms the solubility limit of 3.6% at in HMS. The thermal analysis by DTA suggests the phase separation temperature around 1000K. The phase separation temperature is much lower than the sintering temperature of 1273K, which could limit the thermal conductivity measurement. Therefore, we tried low temperature (950k), high pressure >100MPa, and long sintering method. We successfully obtained the samples with relative density of more than 90%. Further, the detailed analysis of microstructure and transport properties will be shown in presentation.





1. A. Yamamoto, H. Miyazaki, T. Takeuchi, "Thermoelectric properties of Al-(Mn,X)-Si C54-phase (X = Ru and Re)", J. Appl. Phys. 115 (2014) 023708

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