High performance bulk n-type higher manganese silicide

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In this study, we have focused on preparing the cheapest and most efficient higher manganese silicide compound for the thermoelectric generator by introducing heavy W/Re/Ta atoms as the substitute for manganese atoms. We selected heavy elements partly because it was used for the partial substitution for manganese in Si2Ti-type Al-Mn-Si, which has a similar local atomic arrangement with that of HMS [1], and partly because it is non-toxic and assist in reduction of lattice thermal conductivity. Besides, we simultaneously employed Fe substitution for Mn, Fe alters the carrier concentration from p-type to n-type [2].

We prepared $\mathbf{Mn_{31.4-x}Re_2W_2Ta_1Fe_{15}Si_{63.6}}$ by melting high purity Mn, Si, W, Ta, Re, and Fe 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 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 added gluing agent Ag/Sn/Cu and grinded by high energy ball milling, then tried low temperature (950k), high pressure >400MPa, and long time sintering method.

As a result, we succeeded in obtaining n-type HMS in the bulk samples with relative density of more than 90% and **ZT > 0.65**. Further, the thermoelectric properties, Seebeck coefficient, electrical resistivity, and thermal conductivity were measured in a wide temperature range from 300 K to 900 K will be shown in presentation.

References

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