Enhancement of power factor by energy filtering effect in Re substituted HMS

Swapnil Ghodke[1], A. Yamamoto[2], H. Ikuta[1], T. Takeuchi[2,3]

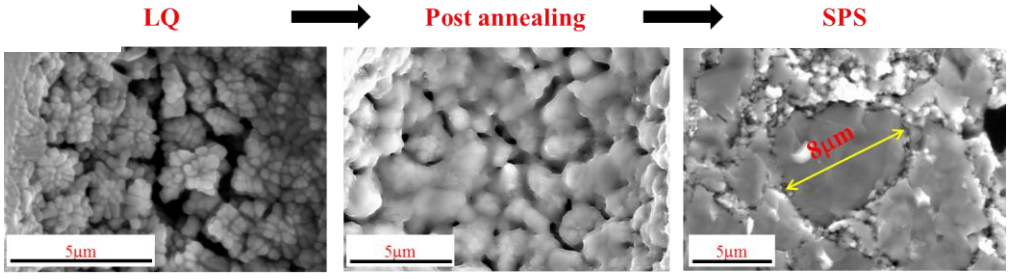
[1]Department of Crystalline Materials Science, Nagoya University, Nagoya, Japan
[2]Toyota Technological Institute, Nagoya, Japan
[3]PRESTO, JST, Tokyo, Japan
E-mail : swapnil@iku.xtal.nagoya-u.ac.jp

Abstract

The higher manganese silicide (HMS) is an promising thermoelectric material, as it is nontoxic, cheap and it possess large Seebeck coefficient 200μVK^{-1} with metallic electrical connectivity 2 mΩcm. The reported Re substituted HMS shows *ZT*=1.04 at 900K which is due to substantial reduction in lattice thermal conductivity [1]. On the other hand, the power factor of HMS can be enhanced by introducing energy filtering effect by grain boundaries [2]. Thus, in this study we combined both mechanisms: 1) reduction of lattice thermal conductivity by Re substitution and 2) energy filtering effect by grain boundaries to obtain high performance HMS.

We prepared ($Mn_{30.6}Re_6Si_{63.4}$) by melting high purity Mn, Si, and Re elements in arc-melting furnace followed by Liquid quenching (LQ) 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 ribbon samples were annealed and then sintered by spark plasma sintering.

The structural and transport properties were analyzed for three different samples: 1) Non-annealed LQ ribbons, 2) Annealed LQ ribbons and 3) Sintered pellet. The powder XRD and SEM data confirms process dependent structural evolution of Re-HMS, the LQ samples show very fine grains (500nm) and coarse grains (8μm) for SPS samples. The Seebeck coefficient show 30-40% improvement in LQ samples compared to SPS sample, which eventually improves power factor by ~35%. The results suggest successful implementation of energy filtering effect in high *ZT* Re substituted HMS. Further, the detailed analysis of microstructure and transport properties will be shown in presentation.



Grain size : 500nm　　Grain size : ~2μm　　Grain size : 8μm

1. A. Yamamoto, S. Ghodke *et al.* “Thermoelectric poperties of super-saturated Re solid solution of higher manganese silicides” Jpn. J. Appl. Phys. (2016) in press
2. S. Ghodke *et al.*, CMCEE-11, American ceramic society, 14-20 June 2015.(Proceedings)