Growth of Mg_2Si thermoelectric crystals with eutectic morphology by unidirectional solidification

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Recently, the improvement of thermoelectric properties by a decrease of thermal conductivity using phonon scattering at nanoparticles is attracting attention in the development of thermoelectric materials[1]. In our previous report[2], we fabricated the $SrTiO_3/TiO_2$ thermoelectric crystal with a eutectic morphology of the TiO_2 rod phase in the $SrTiO_3$ matrix phase by unidirectional solidification from the melt at a eutectic point and the decrease of thermal conductivity could be achieved. Mg_2Si composed of less toxic and inexpensive elements has been actively studied as an environmentally friendly next-generation thermoelectric material[3]. However, the figure of merit *ZT* of the Mg_2Si is greatly reduced due to its high thermal conductivity at low temperatures. Therefore, in this study, we tried to fabricate Mg_2Si thermoelectric crystal with the eutectic morphology to decrease the thermal conductivity and improve the *ZT* by the phonon scattering.

Mg(>2N5) and Si(>3N) powders were mixed at the eutectic point, Mg: Si=47:53, in the Mg-Si phase diagram. Crystal growth was performed using the mixed powder by the Vertical Bridgman (VB) method using various crucibles and insulators in N_2 or Ar. Phases and chemical compositions of the grown crystals were analyzed by powder X-ray diffraction (XRD) measurement and SEM/EDX.

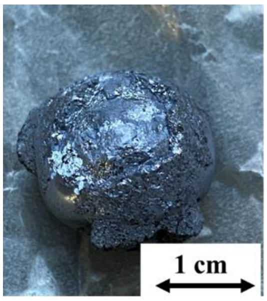

Fig. 1 Grown Mg_2Si/Si eutectic crystal.

Figure 1 is an as-grown Mg_2Si/Si eutectic crystal using a carbon crucible in Ar. The XRD pattern revealed that the grown crystal was composed of only two phases of Mg_2Si and Si. Chemical composition analysis of the grown crystal was performed on the polished surface perpendicular to the growth direction (Fig.2). The SEM image indicated the phase-separated local structure, and only two phases of Mg_2Si and Si were confirmed in the elemental mapping. In this presentation, we will report details of the crystal growth, control of eutectic morphology, and thermoelectric properties of the Mg_2Si/Si eutectic crystals.

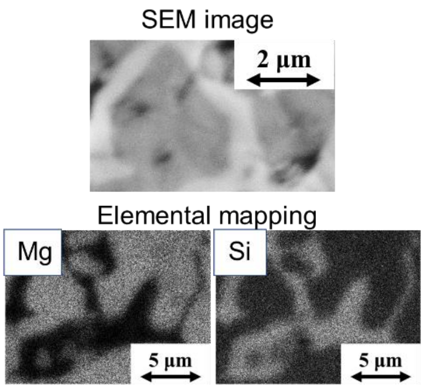

Fig. 2 SEM image and elemental mapping of the grown Mg_2Si/Si eutectic crystal.

References

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