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Thermoelectric Properties of Hot-Pressed Materials Based on $Mg_2Si_nSn_{1-n}$

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$Mg_2Si_nSn_{1-n}$ solid solutions consist of nontoxic widespread elements. In this work a number of samples of $Mg_2Si_nSn_{1-n}$ solid solutions, where $1 \geq n \geq 0.7$ with various carrier concentrations, were obtained using microcrystalline powder by hot pressing in vacuum. The Seebeck coefficient and the thermal and electrical conductivity were measured in the temperature range from 300 K to 800 K. It is shown that the specific thermoelectric figure of merit (the ratio of the thermoelectric figure of merit to the material density) of these samples weakly depends on the composition of the solid solution. Hence, whether a solid solution or pure Mg_2Si is used depends on the application temperature of the material.

Key words: Thermoelectricity, silicide, hot pressing, figure of merit

ZT	Thermoelectric figure of merit
D	Density
S	Seebeck coefficient
σ	Electrical conductivity
κ	Thermal conductivity

INTRODUCTION

This paper is a prolongation of a large cycle of works aimed at improvement of the quality of $Mg_2Si_nSn_{1-n}$ solid solutions for use of these materials in various moving objects. Work on these materials started at the Ioffe Institute in the middle of the 20th century and has been published in many papers, the most important of which is Ref. 1.

$Mg_2Si_nSn_{1-n}$ solid solutions consist of widespread nontoxic elements. Previous complex investigations of electrical properties, thermal conductivities, and band structure features[1–4] have revealed that solid solutions in the Mg_2Si-Mg_2Sn system are very promising n-type materials. Also, solid solutions close to Mg_2Si have lower density than the previously studied $Mg_2Si_{0.4}Sn_{0.6}$ solid solution, allowing their use in moving applications.

Long-time annealing is necessary to prepare homogeneous alloys by the melting method. Cracking of ingots often occurs when synthesizing solid solutions containing ≥80% Mg_2Si. Hot pressing of powders of these materials can solve these problems. Besides, this method provides the opportunity to (a) improve mechanical properties, (b) improve serial issue of materials, and (c) considerably simplify production engineering of thermoelements. The main attention of the present work is directed at investigation of $Mg_2Si_nSn_{1-n}$ solid solutions, where $1 \geq n \geq 0.7$ with various carrier concentrations, because they are the most effective n-type materials at temperatures up to 850 K.

EXPERIMENTAL PROCEDURES

Mg_2Si-Mg_2Sn solid solutions synthesized in a high-frequency generator were crushed in a crusher. The 100 μm to 350 μm size fraction was taken from this powder. Pressing was applied in a vacuum (2 Pa) at a temperature above the temperature of the yield point under a force of 300 kg/cm^2. The process temperature was measured by using a chromel–alumel thermocouple. We cut samples

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