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Transport Properties of Bulk Thermoelectrics—An International Round-Robin Study, Part I: Seebeck Coefficient and Electrical Resistivity

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Recent research and development of high-temperature thermoelectric materials has demonstrated great potential for converting automobile exhaust heat directly into electricity. Thermoelectrics based on classic bismuth telluride have also started to impact the automotive industry by enhancing air-conditioning efficiency and integrated cabin climate control. In addition to engineering challenges of making reliable and efficient devices to withstand thermal and mechanical cycling, the remaining issues in thermoelectric power generation and refrigeration are mostly materials related. The dimensionless figure of merit, ZT, still needs to be improved from the current value of 1.0 to 1.5 to above 2.0 to be competitive with other alternative technologies. In the meantime, the thermoelectric community could greatly benefit from the development of international test standards, improved test methods, and better characterization tools. Internationally, thermoelectrics have been recognized by many countries as a key component for improving energy efficiency. The International Energy Agency (IEA) group under the Implementing Agreement for Advanced Materials for Transportation (AMT) identified thermoelectric materials as an important area in 2009. This paper is part I of the international round-robin testing of transport properties of bulk thermoelectrics. The main foci in part I are the measurement of two electronic transport properties: Seebeck coefficient and electrical resistivity.

Key words: Thermoelectric, Seebeck coefficient, electrical resistivity, round-robin

INTRODUCTION

In the past decade, significant advances have been made to improve the interrelated transport properties of thermoelectrics.[1–3] In particular, materials with low thermal conductivity, high Seebeck coefficient, and low electrical resistivity have been developed to improve the figure of merit, ZT. While some research efforts have been focusing on low-dimensional materials, bulk thermoelectrics have shown the greatest potential in automotive applications. In bulk materials, the classic thermoelectric materials are bismuth telluride,[3] SiGe,[4] and

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