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Thermoelectrics

Fundamentals, Materials Selection, Properties, and Performance

Springer

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Preface

The ability to tailor the properties of materials for a variety of applications will continue to lead to exciting opportunities. In particular, research on materials and devices that address issues such as thermal management, waste heat recovery, and solid-state cooling is anticipated to grow exponentially. The year 2018 marks the 41st anniversary since radioisotope thermoelectric generators (RTGs) were deployed on *Voyager 1* and *Voyager 2*. The long-term performance and reliability of RTGs has led to the multi-mission radioisotope thermoelectric generators that are currently used on the Mars Science Laboratory rover, Curiosity.

Like solar cells, thermoelectric devices have the inherent advantage of the absence of moving parts. However, the thermoelectric energy conversion efficiencies continue to be low. Efforts are in progress to address improvements in their conversion efficiencies by incorporating morphology, alloying, microstructure, and related material properties. The requirements of large Seebeck coefficient and large electrical conductivity coupled with low values of thermal conductivity, for improved thermoelectric performance, continue to challenge solid-state physicists, materials scientists, and device engineers. Chalcogenides (of Pb, Sb, Bi, Sn, La, Cu), Ge-Si, Heussler alloys, oxides, perovskites, skutterudites, and TAGS (tellurium/antimony/germanium/silver) represent some of the materials of interest to thermoelectrics. Recently, flexible and printed organic materials have been investigated for their thermoelectric properties. The convergence in properties of interest, such as narrow bandgap, heavy constituent elements, and significant spin-orbit coupling, in applications such as infrared detectors, thermoelectrics, and topological materials makes the study all the more relevant, timely, and exciting. Nanomaterials/nanocomposites/nanostructures, 1D/2D materials, heterostructures, and quantum dots/superlattices offer potential solutions to problems that limit the ability to control the electrical, electronic, and thermal properties of materials in the bulk.

Thermoelectrics and photovoltaics convert solar infrared and solar visible energy, respectively, into useful electricity. In recent years, energy harvesting technologies have focused on integrating solar thermal and solar visible components into thermoelectric and solar cell farms.

The International Thermoelectric Society provides an excellent forum for dissemination of concepts, ideas, and applications of thermoelectrics. Since the publication of the *CRC Handbook of Themoelectrics*, research on thermoelectrics has been discussed in a number of books in the last two decades.

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