Preface

Research in thermoelectrics is attracting increasing attention recently because the limits of conventional energy sources are rapidly approaching and it is necessary to find new ways to utilize the energy available. In this sense, thermoelectric application is highly beneficial because it can tap into the huge amounts of energy which is otherwise being lost or wasted and convert it into useful electricity. It has been estimated that of the primary energy (gas, oil, coal, etc.) consumed by humans, only one-third is used effectively and two-thirds is wasted, with much of it being in the form of waste heat. Therefore, the benefits of developing effective thermoelectric materials or applications which can utilize such waste heat in direct conversion, is tremendous, and is illustrated well by the increasingly large number of people, scientists, media, and politicians who are interested in this topic.

Presently, there is an intense race throughout the world to develop good enough thermoelectric materials/applications which can be used in wide scale applications. This book has comprehensively focused on very recent up-to-date breakthroughs in thermoelectrics utilizing nanomaterials and methods based in nanoscience, and importantly, will provide the readers with methodology and concepts utilizing atomic scale and nanoscale materials design, in order to achieve this goal. Furthermore, it also has a section devoted to applications of thermoelectrics which is expected to be one of the emerging energy markets.

In detail, the book has three Parts on “Atomic-scale Materials Design”, “Nanoscale Structure Design”, and “Applications of Thermoelectrics”. The first chapter in Part I will give new material design guidelines for developing effective thermoelectric materials (Wang et al.), while other chapters will focus on utilizing atomic nano-cages (Takabatake), layered crystal structures (Terasaki), strong correlations (Søndergaard et al.), Peierls distortion (Rhyee), topological states, i.e. topological insulators (Müchler et al.), modulated structures (Miyazaki and Kikuchi), and natural superlattices (Wan et al.). Part II will mainly deal with important processes for nanostructuring, such as utilizing anisotropy and porosity in bottom-up processing (Datta and Nolas), Severe Plastic Deformation (SPD), (Rogl et al.), grain-size engineering (Liu et al.), assembly of 3D superlattices (Zhang and Koumoto), and nanoinclusion and nanograin process control (Lee et al.). Although, many of the chapters in Parts I and II also include content on applications, the chapters in Part III deal intensively on the topic, with principles given for designing higher efficiency modules (Ouerdane et al.), development of oxide module materials (Funahashi and Kosuga), and solar TEG applications (Weidenkaff et al.).

We feel that this book comprises the cutting-edge, state of the art in thermoelectrics research, which appears now to be finally realistically approaching the long elusive goal of achieving wide scale application. We expect and hope that the book will have a wide appeal and application value for anyone having any interest in thermoelectrics, and on a broader scale, anyone having interest in actual viable applications in nanotechnology. And it should of course be of great value to the dramatically increasing number of researchers and scientists who are involved in or newly trying to join research in this field.

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