## PREFACE: PROGRESS FROM BERGLES-ROHSENOW YOUNG INVESTIGATOR AWARD RECIPIENTS

The ASME Bergles-Rohsenow Young Investigator Award was established in 2003 by the ASME Heat Transfer Division to recognize promising future leaders in heat transfer research, in commendation of two legendary researchers in heat transfer: Warren Rohsenow and Arthur Bergles. As I contemplated the future of heat transfer, I found it appropriate to invite the past recipients of the Bergles-Rohsenow Young Investigator Award to share with us what they are working on. All chapters in the following volume are led by past recipients of this award.

Several chapters in this volume are focused on advancements made in understanding various material properties. In Chapter 1, Ronggui Yang and his co-author, Xiaokun Gu, review the study of phonon transport in two-dimensional materials including graphene, boron nitride, silicene, transition metal dichalcogenides, and black phosphorus. These atomically thin layers possess many unique properties and hold promise for applications in microelectronics, energy, and as structural materials. In Chapter 2, Jonathan A. Malen and his co-author, Wee-Liat Ong, reviewed thermal transport in organic-inorganic hybrid materials, starting from a single interface to crystals of hybrid materials. Such hybrid materials are of great interest because they can be flexible and their properties can be tuned over a wide range. In Chapter 3, Wilson K.S. Chu and his co-authors Matthew B. DeGostin and Alex P. Cocco reviewed synchrotron-based transmission X-ray microscopy techniques to construct detailed 3D microstructural images at nanoscale resolution, with the ability to obtain 3D elemental speciation and chemical bonding information. Such structural information holds the key to understanding structure-property relationships.

Another area that continues to thrive is phase-change heat transfer. This volume includes two chapters on phase-change heat transfer. In Chapter 4, Andrei G. Federov and his co-authors Shankar Narayanan, Peter A. Kottke, and Yogendra K. Joshi presented an overview of thin film evaporation and introduced gas-assisted thin film evaporation techniques. Combined, these techniques have the potential to address both localized and averaged cooling requirements for high-performance microelectronic devices. In Chapter 5, Evelyn N. Wang and her co-authors Shankar Narayanan, Xiansen Li, Hyunho Kim, and Ari Umans presented novel adsorption heat pumps that are capable of providing both heating and cooling to meet the growing demand for electrical vehicle climate control. Their work spans from adsorption materials to system design and integration.

The last two decades have seen significant progress on thermoelectric materials capable of converting heat into electricity via Seebeck effect. Despite progress in materials, however, attention has sparsely been paid to system design. Thermoelectric generators require coupled energy transfer by accepting heat from a heat source and rejecting heat to a heat sink. Thus, system efficiency and cost depend strongly on thermal design. In Chapter 6, Srinath V. Ekkad and his co-authors Jaideep Pandit, Ting Ma, and Scott T. Huxtable summarized strategies and efforts to improve heat transfer for automotive thermoelectric generator systems. Such heat engines can also be designed using pyroelectric effect in some solid-state materials. While thermoelectric energy conversion is based on spatial temperature gradient, pyroelectric energy conversion is based on temporal change of temperature, as in

ISSN: 1049–0787; ISBN: 978–1–56700–454–0/16/$35.00 + $00.00

internal combustion engines. In Chapter 7, Laurent Pilon and Ian M. McKinley reviewed the fundamental and unique properties of pyroelectric materials and the different strategies feasible for using them to directly convert energy from waste heat into electricity.

Although we are all familiar with the first and second laws of thermodynamics, few of us know the Constructal law proposed by Professor Adrian Bejan. The law states, “For a finite-size system to persist in time, it must evolve in such a way that it provides better and better access to the currents that flow through it.” In Chapter 8, Sylvie Lorente presents her work around this law to demonstrate its universality: from the design of porous structures to the optimization of the transport of ionic species in the context of electrokinetics; from the cooling of electronics to underground heat exchangers, thermal energy storage, and distributed energy systems on the landscape.

Papers in this volume reflect the significant evolution of the field of heat transfer over the past few decades. It has expanded to include more studies on materials. These materials and associated applications call for more understanding of heat transfer at micro-/nanoscale, and they in turn are enabling new heat transfer solutions and systems. There is ample room from both ends of the spectrum for us to pursue fundamental studies to improve the materials and application of these materials to develop innovative systems.

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