Preface

The need for advanced thermal management materials in electronic packaging has been widely recognized as thermal challenges became barriers to the electronic industry's ability to provide continued improvements in device and system performance. With increased performance requirements for smaller, more capable, and more efficient electronic power devices, systems ranging from active electronically scanned radar arrays to web servers all require components that can dissipate heat efficiently. This requires that the materials have a high capability for dissipating heat and maintaining compatibility with the die and electronic packaging. In response to these critical needs, revolutionary advances in thermal management materials and technologies for active and passive cooling now promise integrable and cost-effective thermal management solutions. As a result, a large number of papers, articles, and presentations have been published on the development of high-performance materials to solve the vexing problem of device and package-level cooling and thermal management. However, no comprehensive and accessible book has been available on this topic for students, materials scientists, and electronics engineers.

To meet this need, *Advanced Materials for Thermal Management of Electronics Packaging* takes a systems approach ranging from thermal management fundamentals to a balance between cost and performance in materials selection and assessment. Chapter 1 begins with an outline of heat transfer theory and discusses thermal management solutions, materials selection, and component design guidelines. Chapter 2 provides an extensive review of assessment techniques and characterization methodologies for advanced thermal management materials and components. Chapter 3 provides an overview of the state of the art of high-performance advanced electronic packaging materials and their thermal management functions, including properties of key materials, state of maturity, applications, processing, and future directions. Chapters 4 through 8 provide an in-depth introduction to the large and increasing number of advanced thermal management materials, including carbonaceous materials and carbon matrix materials, thermally conductive polymer matrix composites, high thermal conductivity metal matrix composites, ceramic composites, and emerging thermal interface materials. Chapters 9 through 11 discuss advanced materials and design for heat spreaders, air cooling heat sinks, liquid

cooling, and thermoelectric cooling devices. Finally, Chapter 12 presents a development roadmap with applications, trends, and perspectives on the future.

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