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Contributions from Thermal Challenges in Next Generation Electronic Systems (THERMES)

S V. Garimella
Purdue Univ, sureshg@purdue.edu

Yogendra K. Joshi
Georgia Institute of Technology

Foreword
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AS ELECTRONIC products become faster and incorporate greater functionality, they are also shrinking in size and weight, with continuing pressures for cost reduction. Thermal issues are key in electronic product development at all levels of the electronic product hierarchy, from the chip to the ultimate system. Shrinking system sizes are resulting in increasing volumetric heat generation rates and surface heat fluxes in many products. This has resulted in a significant interest in ultra-compact thermal management devices with high heat removal capabilities. Additional thermal management challenges arise as more and more electronic systems are employed in harsh environments, subject to large variations in ambient temperatures and external thermal loads. A synergistic activity is thermal characterization through computations. High-fidelity modeling schemes are being sought, as product development cycles shrink to a period of months in many portable products.

The United Engineering Foundation Workshop "Thermal Challenges in Next Generation Electronic Systems (THERMES)," was held in Santa Fe, NM, January 13–16, 2002, with support from the U.S. National Science Foundation. The focus was on recent advances in thermal management and characterization schemes, as well as forecasts and analyzes of future trends. Three keynote lectures and nine invited talks in selected emerging areas from leading experts in industry and academia were complemented with contributed papers organized into nine technical sessions. Five panel discussions focused on technology and market trends and identification of research challenges.

Discussions engendered by the keynote and invited lectures, panel discussions, and contributed papers as well as informal conversations, pointed to a consensus that the key needs in thermal management for next generation electronic systems should include considerations of the following.

1) Compact high-heat-flux devices.
2) Chip level nonuniformities.
3) Holistic view of thermal management.
4) Autonomic resource management.

In addition, the following needs in thermal characterization of electronics were emphasized.

1) Computationally efficient multi-scale methods.
2) New considerations for data centers.
3) Transients.

Selected papers from the conference have been reviewed and are appearing in this special issue of the IEEE TRANSACTIONS ON COMPONENTS AND PACKAGING TECHNOLOGIES and a companion issue of the *Microelectronics Journal*. We are grateful to all the contributors and reviewers.

SURESH V. GARIMELLA
Purdue University
West Lafayette, IN 47907-1288 USA

YOGENDRA K. JOSHI
Georgia Institute of Technology
Atlanta, GA USA

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Suresh V. Garimella received the M.S. degree in mechanical engineering from Ohio State University, Columbus, and the Ph.D. degree in mechanical engineering from the University of California at Berkeley, in 1989.

He is a Professor of mechanical engineering at Purdue University, West Lafayette, IN, and the Director of the NSF Cooling Technologies Research Center (CTRC—an NSF Industry/University Cooperative Research Center). He also directs the Electronics Cooling Laboratory and the Solidification Heat Transfer Laboratory. His research interests include high-performance compact cooling technologies, electronics packaging and cooling, micro-scale and nano-scale thermal phenomena, and electronic and composte materials processing. From 1990 to August 1999, he held the Cray-Research Named Professorship at the University of Wisconsin, Milwaukee. He has published over 120 papers in archival journals and in conference proceedings, and has also contributed to, and edited, several books. He has served as Editor of *Heat Transfer-Recent Contents and on the Editorial Board of Experimental Thermal and Fluid Science*.

Dr. Garimella is a member of the K-16 (Heat Transfer in Electronic Equipment) committee of the Heat Transfer Division of the ASME.

Yogendra K. Joshi is a Professor of mechanical engineering at the Georgia Institute of Technology, Atlanta, where he is active in research and instruction in the area of thermal engineering. His recent activities have been in three broad areas: compact thermal management devices, conjugate transport mechanisms with multiscale systems and transport in semiconductor manufacturing and assembly processes. He is the author or coauthor of 55 journal articles and numerous conference papers. He served as Associate Technical Editor of the ASME *Journal of Electronic Packaging*, from 1996 to 2001.

Dr. Joshi received the 1999 Curriculum Innovation Award and is a Fellow of the American Society of Mechanical Engineers.