MECHANICAL ENGINEERING DEPARTMENT
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Macro/Micro/Nanoscale Heat Transport and Bridging of Spatial and Temporal Characterization in Thin Films, Superlattices and Periodic Multi-Layer Structures

by

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Wednesday, February 13, 2008
3:15 p.m. — Refreshments before the seminar
3:30 p.m. — Graduate Seminar
Room 1130 ME

ABSTRACT — Today, to achieve technological breakthroughs, our need to design and produce materials and structures that are several thousand times smaller than a single human hair, has created an exciting environment for fabrication of materials at these scales by bringing together physicists, chemists, biologists and engineers to manipulate matter at very small scales. The general area of nanoscale science and engineering is very broad and diversified. However, to sharpen the focus of this presentation, one particular discipline, namely, the state-of-the-art in heat transfer at these small scales including more recent developments is overviewed. Particular attention is paid to the bridging of spatial and temporal characterization in heat transport in thin films, superlattices and multi-layer structures with emphasis on the property, namely, thermal conductivity at various length scales, and experiments versus modeling and simulation.

To a novice, or take a typical engineer for example, the dilemma is how much background is needed, and what is the balance between science and engineering that is required to come to a satisfactory compromise in an academic setting? With this thought process in mind, in this presentation, an overview of the motivation via practical engineering applications and predominant experiments conducted to explore heat transport characteristics is first highlighted. The follow up question is the ability to provide an improved understanding of the physics of heat transport via modeling and simulation to confirm/complement experimental results. With regard to the latter, numerous developments have been advanced since the past two decades including heat transport models, molecular dynamics simulations, and the like. These are briefly discussed and the pros/cons are highlighted with particular attention to a relatively simple and practical, yet effective unified theory of heat conduction emanating from the physics of the Boltzmann Transport Equation (BTE) that bridges both spatial and temporal scales and termed as the C- and F- processes model. A new Heat Conduction Model Number is advanced, and the developments are described for the study of heat conduction in thin films, superlattices and multilayer structures via comparisons of modeling and simulation with experiments.

BIO — **Dr. Kumar K. Tamma**, is currently Professor in the Department of Mechanical Engineering at the University of Minnesota. He has published over 160 research papers in archival journals, and over 210 research papers in refereed conference proceedings and book chapters. His principal areas of research encompass: Computational mechanics with emphasis on multi-scale/multi-physics in space and time with particular reference to advances in the design and development of novel numerical methods and computational techniques, and algorithms by design; fluid-thermal-structural interactions; structural and multi-body dynamics; composites and manufacturing processes; and computational aspects of macro/micro/nanoscale heat transfer. He is the recipient of numerous research and teaching awards. He currently serves on the editorial boards for over a dozen journals in his fields of expertise, and has given numerous Plenary and Keynote lectures in the various fields of his expertise.

Informal Faculty Luncheon: Wednesday, February 13, 2008, 12:00 noon. Meet in 1100 ME and walk to lunch with other faculty. Prof. Tamma will be able to attend.