IIS 056

Development of a Lattice Boltzmann Based Nanoscale Heat Transfer Model and its Application to Electronics and Data Storage Industry

Myung S. Jhon
Professor, Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA

Mehdi Asheghi
Assistant Professor, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA

Cristina H. Amon
Director, Institute for Complex Engineered Systems, Carnegie Mellon University, Pittsburgh, PA

Sartaj S. Ghai
Graduate Student, Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA

Ashraf Abu Akeel
Undergraduate Student, Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA

Industry Participants
Seagate Research, Pittsburgh
Bettis Atomic Power Laboratory, West Mifflin.
National Energy Technology Laboratories (NETL), Pittsburgh and Morgantown.

Abstract

The goal of this project is to construct advanced simulation tools for nanoscale heat transfer in solids based on fundamental scientific principles. A 3-D simulation code based on the Lattice Boltzmann Method (LBM) will be developed. The LBM, which stems from the Boltzmann Transport Equation (BTE) and lattice gas automata, is an alternative numerical technique for modeling nanoscale heat transfer in solids. While portraying similar behavior as the BTE, the LBM requires considerably less computational effort. To verify our LBM code, we intend to study the thermal behavior of complex and relevant geometries by solving the numerically intense BTE, as well as verifying the various heat transfer hierarchy equations (e.g., Fourier, BTE, and LBM). Our applications so far are geared towards semiconducting solids, in which the dominant carriers are phonons. With proper implementation of physics, our numerical scheme will be enhanced to examine the metallic solids, in which the dominant heat carriers are electrons (although interaction of both energy carriers and electron-phonon coupling will make the problem challenging). This project aims for a multidisciplinary, high technology enabling research program that will create viable applications within nanotechnology and promote collaborative opportunities among the faculty and students of CIT.