AES Seminar

Assistant Professor, Smead Aerospace

Phonon and Electron Transport in Nanostructured Semiconductors: A Perspective for Aerospace Applications

Wednesday, Oct. 10, 2018 | DLC | 12:00 P.M.

Abstract: Heat conduction in macroscopic continuum media is well described by classical physics. However, with continued miniaturization of electronic transistors, sensors and actuators, device dimensions are now reaching the nanoscale. Classical framework fails to explain heat conduction in nanoscale materials. It is imperative to take into account the atomistic nature of matter, effects of confinement and dimensionality, and the interaction of lattice vibrations with electrons and photons, to analyze nanoscale heat transport. Quantized lattice vibrations, phonons, provide a natural framework to describe heat transport in nanoscale materials. In semiconductors, heat is primarily transported by broadband high-frequency THz phonons with nanometer wavelengths. Therefore, a broad range of phonon frequencies needs to be engineered to control heat conduction, in contrast with electronic applications, where only energies close to the Fermi level are relevant. The difficulty of working with a broad spectrum of excitations naturally poses major challenges in achieving control over nanoscale phonon transport.

Engineered nanoscale features have shown remarkable possibilities to manipulate phonons and thus guide heat in nanostructures. Efforts to control phonons, especially at the micro- and nanoscale, have been further stimulated by the ever increasing roles that phonons assume via self-interaction and interaction with electrons, photons and other fundamental quantum particles. My research program at CU boulder is focused around the central theme—to tune phonons and their interactions with other quantum particles via engineering of nanostructured materials—in order to enable a broad range of technological applications. Our aim is to devise structural engineering strategies to engender desired transport of quantum particles in materials.

In this seminar, I will present an overview of the research activities in my group, the CU Aerospace Nanoscale Transport Modeling (CUANTAM) Laboratory, in particular,

- phonon and electron transport in multilayered nanostructured thermoelectric materials,
- electron-phonon interaction in silicon/germanium heterostructures,
- guiding heat in thin-film nanostructures with engineered surfaces,
- prediction of charge transport in multilayered semiconductors using machine learning techniques,
- probing spin-phonon interaction in defected semiconductors to enable quantum applications.

I will discuss illustrative strategies we devise to mitigate thermal constraints and overcome the limits of performance in complex aerospace electronic applications.

Bio: Sanghamitra Neogi is an Assistant Professor in the Smead Aerospace Engineering Sciences Department at the University of Colorado Boulder since Fall 2015. She received her Ph.D. in Theoretical Condensed Matter Physics from Pennsylvania State University in 2011 and was a postdoctoral research associate at the Max Planck Institute for Polymer Research, Mainz, Germany.

Smead Aerospace
UNIVERSITY OF COLORADO **BOULDER**

Be Boulder.