MCEN GRADUATE SEMINAR

Thermal Energy Transport and Conversion in Nanostructures

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Abstract: The fundamental length scales associated with the basic heat carriers, such as phonons and electrons, generally fall in the range of 1-1000 nm. Therefore, exploring and exploiting basic nanoscale thermal transport and conversion phenomena hold the key for developing high performance materials and devices for thermal energy conversion and management. There has been extensive research and progress in this area, most notably on two fronts: 1) pushing the lower limit of thermal conductivity in electrically conductive materials, with potentials for thermoelectric applications; 2) enhancing the thermal conductivity of electrically insulating and soft materials, such as polymers, for thermal packaging applications. However, there are still numerous fundamental questions that remain elusive. For example, what is the limit of thermal conductivity when nanostructure size is approaching the fundamental phonon transport length scale such as wavelength? Can we break the amorphous limit of thermal conductivity? And how to understand and control the microstructures of polymers to enhance their thermal conductivity.

In this talk, I will present our recent work on using rationally-designed nanostructures and new instrumentations to experimentally study thermal transport and conversion phenomena. Specifically, I will present two materials systems, namely, nanowires and multilayers, which show ultralow thermal conductivities (lower than the amorphous limits). I will also show that there is a close correlation between mechanical and thermal properties in nanostructures of two distinctly different materials, silicon and polymer. This correlation turns out to be crucial to understand the ultralow thermal conductivity of crystalline Si nanostructures and also to elucidate the significant Young's modulus enhancement extensively studied in polymer nanofibers.

Bio: Renkun Chen received his Ph.D. degree in Mechanical Engineering from the University of California, Berkeley in 2008, and a B.S. degree in Thermo-physics from Tsinghua University in 2004. Following a one-year stint as a postdoctoral fellow at Lawrence Berkeley National Laboratory, he joined UC San Diego as an Assistant Professor in the Department of Mechanical and Aerospace Engineering in 2009. His research interests include nanoscale heat transfer, energy conversion materials, solar energy, and thermal management. He is a recipient of a R&D 100 award and a Hellman Faculty Fellow award.