MATERIALS SCIENCE AND ENGINEERING

SEMINAR

"Silicon Nanowires for Thermoelectric Applications"

by

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ABSTRACT

Thermoelectrics are a promising approach for solid state power generation from waste heat, but commercial viability will rely on the discovery of new thermoelectric materials with high thermoelectric figure of merit (ZT) values. ZT values of current commercially available thermoelectrics are approximately one, whereas widespread utilization will require ZT values greater than two. Bulk silicon, a poor thermoelectric material (ZT = 0.01) due to its high thermal conductivity (~150 W/m-K), would not seem to be an ideal candidate for thermoelectrics research. However, silicon's potential as a thermoelectric material improved after two Nature journal articles (January 2008) reported the fabrication of silicon nanowires exhibiting thermal conductivity values up to two orders of magnitude lower than bulk silicon. The reduction in thermal conductivity is caused by increased phonon scattering due to reduced nanowire dimensions, increased surface roughness, and doping effects. The phonon scattering mechanisms do not appreciably alter the electronic properties, leading to enhanced ZT values approaching one. Silicon nanowire fabrication techniques, measurement devices, and electrical/thermal results from the two Nature articles will be discussed and compared. A set of recommendations will be outlined to further the understanding of the effect of nanowire dimensions and surface roughness on reducing thermal conductivity.

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