Mechanical Engineering Department Seminar

3:30pm October 17, 2012
1130 Mechanical Engineering

Heat Transfer in Graphene and Nanocrystalline Materials

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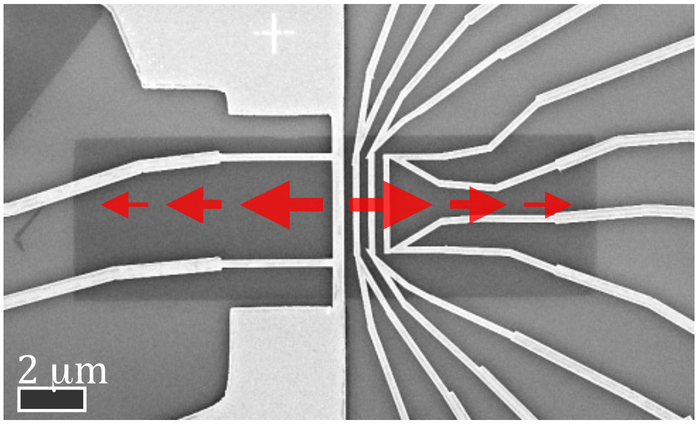
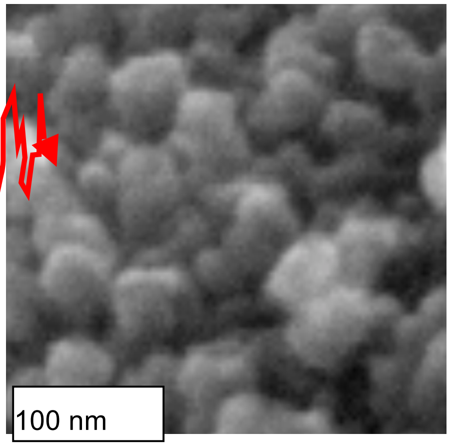
The thermal conductivity of nanostructured materials can differ from that of their bulk single-crystal counterparts by orders of magnitude, with major impacts on diverse applications including transistors, lasers, and energy conversion. Here I will describe two examples:

(1) Although suspended graphene has been reported to have very high in-plane thermal conductivity, most applications would require graphene to be supported or encased within dielectric layers. Our measurements of encased graphene and ultrathin graphite show that the constraints of the encasing layers reduce the in-plane thermal conductivity by at least a factor of 10 as compared to bulk graphite.

(2) Bulk nanocrystalline materials are appealing because they combine some of the performance advantages of nanostructuring with scalable, low-cost synthesis. To clearly quantify the effects of grain boundaries in reducing the phonon thermal conductivity in such materials, we measured undoped nanocrystalline silicon as a model system. The results show that the effective boundary scattering length is somewhat smaller than the average grain size, and reveal a previously unidentified frequency dependence which we show is consistent with asymptotic analysis of atomistic simulations from the literature.



Graphene



Nano-crystalline Silicon

Bio Chris Dames received his PhD in Mechanical Engineering from the Massachusetts Institute of Technology in 2006. His BS and MS are from UC Berkeley (1998, 2001). He was a faculty member at UC Riverside from 2006-2011 before joining UC Berkeley in 2011, and he has also worked as a research engineer for Solo Energy Corp. (1998-1999). He is a recipient of a DARPA Young Faculty Award (2009) and an NSF CAREER award (2011). His research interests emphasize fundamental theoretical and experimental studies of heat transfer and energy conversion at the nanoscale. Some topics of current interest include graphene, nanocrystalline materials, mean free path distributions, thermoelectrics, biological systems, and highly anisotropic and nonlinear transport including thermal rectification.