Abstract

Phonons and thermal transport in nanoscale devices and nanomaterials

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Received: Tue Jun 25 14:18:37 2002

Although mesoscopic electron physics has been under intense study for over 15 years now, the regime of mesoscopic phonon physics, where the phonon wavelength becomes comparable to the size of the structure under study, has been much more difficult to access experimentally. To reach this regime, we have fabricated freely-suspended integrated semiconductor devices and performed the first direct thermal transport measurements on nanostructures. We have used these devices to provide the first experimental measurement of the quantum of thermal conductance in one-dimensional phonon waveguides. We have performed theoretical modelling that allows us to correlate the details of our thermal conductance measurements with the physical structure of our devices. We have also used similar devices to measure thermal transport at higher temperatures, in order to directly observe surface effects on phonon scattering in nanostructures. Finally, we have examined the thermal properties of carbon nanotubes, whose small size and high phonon velocity allows them to show quantum effects at relatively large temperatures. These measurements also allow us to probe the mechanical properties of the nanotubes, such as their stiffness (Young's modulus) and the coupling between neighboring tubes in bundles.

¶Presenter