MAR14-2013-020366

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Thermal transport in amorphous nanostructures: the (enduring) role of low-energy phonons

JASON UNDERWOOD, NIST - Boulder

Micromachined amorphous solid structures have proven to be ideal platforms for physicists to challenge their understanding of phonon transport. Such nanostructures have been exploited for early experimental demonstrations of the quantum of thermal conductance. These structures also serve important technological functions. Amorphous silicon nitride (SiN_x) nanostructures, in particular, are increasingly critical to the operation of state-of-the-art low temperature detector arrays. Achieving control over which phonon modes propagate in a given structure — phononics — is a major goal for engineering better thermoelectric materials, for regulating heat flow in ever-shrinking microprocessors, and for the developing field of caloritronics. At very low temperatures, it is generally accepted that phonons with energy much lower than the Debye energy (i.e., $\omega \ll 10^{13}$ Hz) dominate thermal transport. At room temperature, the preponderance of higher energy modes is usually reason enough to assume that the low energy modes do not contribute substantially to the overall thermal conductance. While generally true for crystals, the efficient scattering of high-energy phonons in amorphous solids means that the remaining low-energy modes may acquire comparably long mean free paths. Recent measurements of SiN_x nanostructures strongly suggest that this bias in mean free paths leads to the result that low-energy phonons may contribute up to 50% of the overall thermal conductance of the structure — even at room temperature. After a brief review of thermal transport in the low-energy regime, I will discuss these results, as well as other recent experiments where low-energy phonons play an important role.