DETERMINATION OF NANOWIRE THERMAL CONDUCTIVITY BY SOLVING THE PHONON BOLTZMANN TRANSPORT EQUATION

Sebastian Volz and Denis Lemonnier
Laboratoire d'Etudes Thermiques (UMR CNRS 6608)
Ecole Nationale Supérieure de Mécanique et d'Aérotechnique
BP. 40109, 86961 Futuroscope Chasseneuil, France

ABSTRACT. The phonon Boltzmann transport equation is used to calculate the thermal conductivity in clamped and free standing silicon nanowires and study both boundary and confining effects of phonon scattering. The solution method includes partly diffuse and specular phonon reflections at the boundaries and introduces a spectral extinction coefficient. This parameter is derived from the Umklapp relaxation time accounting for thermal resistive processes. A numerical scheme based on the discrete ordinates method has been developed. Results are presented for several wire lengths and extrapolated to infinite wires. Fourier's law is retrieved both theoretically and numerically for acoustically thick media when only specular reflections occur.