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Transfer of Heat Between Electrons and Phonons in Metallic Nanostructures

S. Cojocaru and D. V. Anghel
National Institute of Physics and Nuclear Engineering, Magurele, Romania

It is demonstrated explicitly on an example relevant for nano- and micro-scale sensors, bolometric and microcaloric devices how the nanoscale confinement of electron and phonon subsystems affects their coupling and heat exchange. The temperature dependence of the transferred power, P(T), is considered for a layered metal-insulator structure. It is shown that below the phonon crossover temperature T* the heat transfer is strongly enhanced while its T-dependence becomes weaker than in the bulk material. The phonon modes responsible for this enhancement are identified and the analytic form of P(T) is derived, which suggests ways of controlling the heat flux. Quantitative accuracy is confirmed by comparing to the results of recent experiments.