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1D Phonon BTE Solver (Small Scale Heat Transport Simulation)

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ABSTRACT

In current technology, electronic devices shrink to the size of nanometers. The ability to accurately model heat transport to understand the thermal behavior of these small electronic devices becomes increasingly important. Since heat transport is very difficult to measure directly in small electronic devices, simulation becomes an effective means to model heat transport. A user-interactive simulation tool is created to model heat transport in small electronic devices of different lengths. Heat transport is modeled by solving one-dimensional Boltzmann transport equation (BTE) to obtain the transient temperature profile of a multi-length and multi-timescale thin film under constant temperature boundary condition or under hotspot cooling process. Unlike Fourier Heat equation, BTE can capture the effect of ballistic phonon transport expected at short lengh/time scale. Rapid Application Infrastructure (Rappture), a toolkit used to create user-interactive graphical user interface, is used to create the user interface for this simulation. The inputs to the simulation tool are thin film length and simulation time specified by user. BTE is then solved by using Lattice Boltzmann method (LBM) in MATLAB to obtain the temperature profile plot. The temperature profile plot explains how the temperature changes throughout the entire length of the material. This simulation tool allows users to accurately simulate heat transport in small electronic devices of different lengths that will help them in the thermal design and thermal management of small electronic devices.

KEYWORDS

BTE, heat transport, phonon transport, simulation, nanohub