Abstract Submitted
for the 4CF15 Meeting of
The American Physical Society

Multi-scale method for analysis of self-heating in nano-electronic devices ROBIN DAUGHERTY, SULEMAN QAZI, ABDUL SHAIK, DRAGICA VASILESKA, Arizona State University — Electrons in semiconductor devices under bias gain energy in an electric field and scattering events cause energy exchange with the crystal lattice (where the energy is transported as heat). Due to the nature of these interactions, it is possible for hot spots to form in electronic devices which can be detrimental to device performance. Electrons exchange energy with the lattice in the form of optical and acoustic phonons. The rate of energy exchange due to scattering events is faster for optical phonons than for acoustic phonons, which leads to a concentration of energy into the optical phonon bath. Optical phonons must decay into acoustic phonons before the energy can be dissipated as heat; this decay is slow and results in localized hot spots in active regions of semiconductor devices. The Monte Carlo method is used to solve the Boltzmann transport equation for electrons and the energy balance model is used to calculate the acoustic and optical phonon temperatures to be fed back into the Monte Carlo transport kernel. The electro-thermal device simulator is then self-consistently coupled with a thermal transport solver at the interconnect level. This multi-scale approach gives a good result for the hot spot location and temperature.

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Date submitted: 11 Sep 2015 Electronic form version 1.4