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Bloch Oscillations and Saturation to a Steady-State Current of an Electron Gas in a Modulated Quantum-Wire Superlattice in a High Electric Field[1] S.K. LYO, Sandia National Laboratories, D. HUANG, Air Force Research Laboratory, W. PAN, Sandia National laboratories — We present rigorous theoretical results for the time-dependent and steady-state nonlinear DC current of an electron gas in a periodically modulated one-dimensional semiconductor quantum wire in a high electric field. The theoretical model considers electron-phonon and impurity scattering microscopically in the degenerate and the nondegenerate regime in a tight-binding model. The time-dependent oscillatory and saturation (i.e., steady-state) currents are studied as a function of the field, the radius of the wire, the elastic scattering rate, the lattice period, and the temperature. The radius controls the inelastic scattering rate. The distinctive roles of elastic and inelastic scattering for the current are contrasted and examined. Finally, we compare the results with those from an exact analytic formalism based on a relaxation-time model.

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S.K. Lyo
Sandia National Laboratories

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