Non parabolic band hydrodynamical model of semiconductors and simulation of electron devices

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Abstract

A consistent hydrodynamical model for electron transport in silicon semiconductors, free of any fitting parameter, has been formulated in [1, 2] on the basis of the maximum entropy principle, by considering the energy band described by the Kane dispersion relation. Explicit constitutive functions for fluxes and production terms in the macroscopic balance equations of density, crystal momentum, energy and energy-flux have been obtained. Scatterings of electrons with non polar optical phonons (both for intervalley and intravalley interactions), acoustic phonons and impurities have been taken into account.

Here [3] we show the link with other macroscopic models describing the motion of charge carriers. In particular, under suitable scaling assumptions, an energy transport model is recovered. An analysis of the formal properties is given by showing that the evolution equations form a hyperbolic system in the physically relevant region of the space of the dependent variables. Al last, by using the numerical method developed in [4, 5], simulations for bulk silicon and $n^+ - n - n^+$ silicon diode are performed. The obtained results are in good agreement with Monte Carlo data.

References

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