Leonard F Register, J Nanomater Mol Nanotechnol 2017, 6:4 (Suppl)
DOI: 10.4172/2324-8777-C1-008

16th World Nano Conference

June 05-06, 2017 Milan, Italy

Leonard F Register

University of Texas at Austin, USA

Ensemble Monte Carlo methods and results for nanoscale Si and III-V n-channel FinFETs; non-equilibrium degenerate statistics, quantum-confined scattering and more

Particle-based ensemble semi-classical Monte Carlo (SCMC) remains a benchmark in semiconductor device research, because of combination of relative computational efficiency, first-principles transport physics, and the ready ability to model scattering. The latter contributes not just to injection efficiencies, but screening of potential wells, thermalisation of carrier distributions (particularly among energy valleys), and source drain-resistance. However, particle-based ensemble semi-classical Monte Carlo (MC) methods must employ quantum corrections (QCs) to address quantum confinement and degenerate carrier populations to model today's and tomorrow's ultra-scaled MOSFETs. We describe the most complete treatment of quantum confinement effects and carrier degeneracy in a three-dimensional (3D) MC device simulator to date, and apply them to simulation of n-channel Si and III-V FinFETs. Far-from-equilibrium degenerate statistics (beyond hot Fermi distributions), QC-based modeling of surface-roughness scattering, quantum-confined phonon and impurity scattering are considered, in addition to quantum confinement-induced redistribution of charge carriers in real-space and momentum-space. The use of fractional "subcarriers" also minimizes classical carrier-carrier scattering that is incompatible with degenerate statistics, as well as providing improved statistics. FinFET simulations illustrate the contributions of each of these QCs. We show how collectively these modeled quantum effects can substantially reduce and even eliminate otherwise expected benefits of a considered $In_{0.53}Ga_{0.47}As$ FinFET over Si but otherwise identical Si FinFET, despite lower bulk electron masses and higher mobilities and thermal velocities in $In_{0.53}Ga_{0.47}As$, as illustrated in Fig. 1.

Biography

Leonard F Register completed his J. H. Herring Centennial Professorship in Engineering within Electrical and Computer Engineering department at University of Texas at Austin. He is a member of Microelectronics Research Center; Fellow of Institute of Electrical and Electronics Engineers (IEEE) and; Fellow of the American Physical Society (APS). He is a Device Theorist whose research is focused on "Understanding and modeling nano-scale electronic and mageto-electronic devices and the essential physics underlying their operation". His current research interests include "Alternative materials and device geometries for CMOS; alternative materials, state variables and switching methods for beyond CMOS devices and memory; and quantum transport and quantum-corrected semi-classical transport".

register@austin.utexas.edu

Notes: