Two dimensional analytical threshold voltage model of nanoscale strained Si/Si1-Xgex Mosfets Including quantum mechanical effects

Abstract

A new analytical model derived from the Poisson equation for surface potential and threshold voltage (V_{th}), including the Quantum Mechanical Effects (QMEs) is presented for nanoscale strained $Si_{1-x}Ge_x$ MOSFETs. Boundary condition approaches are applied in the model. The threshold voltage analytical model is developed using 20% germanium content in $Si_{1-x}Ge_x$ substrates. The model is developed to investigate the quantum mechanical effects on the magnitude of surface potential and threshold voltage. The impacts of strain and quantum confinement on the shift of threshold voltage are explained. Our threshold voltage model incorporates the quantum oxide thickness and the effective flatband voltage. For the validation purpose, the developed threshold model is verified using 2D ATLAS simulation results. The results obtained from the developed model have a good agreement with the simulation results. Both the analytical and the simulation results demonstrate a significant increase of threshold voltage in strained silicon considering the quantum mechanical effects.