Modelling of nanoscale multi-gate transistors affected by atomistic interface roughness

Título Modelling of nanoscale multi-gate transistors affected by atomistic interface roughness


Tipo Artículo de revista


Rank Provisionally ranked Q1 in Condensed Matter Physics by SJR 2017

ISSN 0953-8984

DOI 10.1088/1361-648X/aab10f

Abstract Interface roughness scattering (IRS) is one of the major scattering mechanisms limiting the performance of non-planar multi-gate transistors, like Fin field-effect transistors (FETs). Here, two physical models (Andos and multi-sub-band) of electron scattering with the interface roughness induced potential are investigated using an in-house built 3D finite element ensemble Monte Carlo simulation toolbox including parameter-free 2D Schrödinger equation quantum correction that handles all relevant scattering mechanisms within highly non-equilibrium carrier transport. Moreover, we predict the effect of IRS on performance of FinFETs with realistic channel cross-section shapes with respect to the IRS correlation length ($\delta$) and RMS height ($\delta_{RMS}$). The simulations of the n-type SOI FinFETs with the multisub-band IRS model shows its very strong effect on electron transport in the device channel compared to the Andos model. We have also found that the FinFETs are strongly affected by the IRS in the ON-region. The limiting effect of the IRS significantly increases as the Fin width is reduced. The FinFETs with (1 1 0) channel orientation are affected more by the IRS than those with the (1 0 0) crystal orientation. Finally, $\delta$ and $\delta_{RMS}$ are shown to affect the device performance similarly. A change in values by 30% ($\delta$) or 20% ($\delta_{RMS}$) results in an increase (decrease) of up to 13% in the drive current.

Palabras chave drift-diffusion (DD), finite element (FE) method, Monte Carlo (MC), Multi-sub-band interface roughness scattering (IRS), Schrödinger based quantum corrections