Abstract

The work described in this dissertation has concentrated mainly on two topics: (i) development of a two dimensional device simulation program, DEVAM, for simulation of Si/SiGe bipolar and MOS devices and (ii) analysis of a *npn* HBT and a SiGe channel p-MOSFET using DEVAM. The device simulation program is developed with an aim to study the terminal behaviour of Si/SiGe devices without going through the costly process of fabrication. A brief review on SiGe material is done. The models of physical parameters which are used in this simulator are: (i) the bandgap lowering due to heavy doping effects, (ii) Shockley-Read-Hall, Auger and surface generation/recombinations and impact ionisation, and (iii) the electron and hole mobilities considering their dependence on doping concentration, temperature, electric field and injection level. The different physical parameters such as dielectric constant, energy bandgap, density of states, intrinsic and effective carrier concentrations, electron affinity, mobilities and recombination phenomena which are dependent on the composition of the SiGe alloy, are are also computed. Both coupled and decoupled approaches are used to solve the semiconductor transport equations in DEVAM. The boundary conditions considered are oxide-semiconductor interface, ohmic and Schottky contact in both voltage and current controlled modes. The step by step implementation of DEVAM is outlined. An *npn* SiGe heterojunction bipolar transistor (HBT) is analysed and the results are discussed. An analytical expression is proposed to estimate the current enhancement in SiGe HBTs. The dependence of current gain on temperature and Ge mole fraction has been studied. Analysis of a SiGe channel p-MOSFET is done with an aim to optimise the design and the computed results are found to be in fair agreement with those of experimental ones available in the literature.

Key words:

DEVAM, Gummel decoupled approach, coupled approach, finite element method, device modelling, strained layer, lattice mismatch, critical thickness, mobilities, heterojunction, current roll off, germanium mole fraction, bandgap, band grading, band alignment, cross over voltage, subthreshold slope.