

Numerical Evaluation of Low-Dimensional Energy Spectrum and Carrier Statistics for Nanostructure Device Application

Abstract

Numerical evaluation of energy spectrum and carrier statistics for nanostructure device application is presented. The low-dimensional energy spectrum was successfully derived for the respective quasi 3D, 2D and 1D system that invoked the effect of quantum confinement (QCE) comparable to the De Broglie wavelength ($\lambda_D \approx 10\text{nm}$). For non-degenerately (ND) doped samples the Fermi-Dirac (FD) integral is well approximated by Boltzmann statistics. However, in degenerate doped quasi 3D, 2D and 1D device, the FD integral is found to be approximated by order one-half, zero and minus one-half respectively. The Fermi energy is revealed to be a weak (logarithmic) function of carrier concentration, but varies linearly with temperature in the ND regime. However, for strongly degenerate statistics, the Fermi energy is independent of temperature and is a strong function of carrier concentration.