Numerical analysis of carrier statistics in lowdimensional nanostructure devices

Abstract

The carrier statistics for low-dimensional nanostructure is elaborated. The density of state (DOS) is proportional to $d\,D\,\lambda$ where d is the dimensionality of the nanostructure and $D\,\lambda$ is the De-Broglie wavelength proportion of Fermi-Dirac (FD) integral that covers the carrier statistics to all degeneracy level. In the non-degenerate regime the results replicate what is expected from the Boltzmann statistics. However, the results vary in degenerate regime. The results for all dimensions are numerically analyzed and compared for all three Cartesian directions. With appropriate DOS, the carrier concentration in all dimensions is obtained based on the FD statistic. Fermi energy with respect to band edge is a function of temperature that is independent of the carrier concentration in the non-degenerate regime. In the strongly degenerate regime, the Fermi energy is a function of carrier concentration appropriate for given dimensionality, but is independent of temperature.