Objectives

III-V nano-heterostructure devices have higher mobility and high saturation velocity which is suitable for high speed devices. Due to direct band gap nature of III-V semiconductors, they make excellent optical devices because for an indirect gap semiconductor, light emission is painfully inefficient, making optical devices such as lasers impractical and poorer intrinsic speed for Si becomes problematic especially when operated in microwave frequency range.

Semiconductor diode lasers used in CD, DVD players and fiber optic transceivers are manufactured using alternating layers of various III-V compound semiconductors to form lasing heterostructures, which will be very efficient. For making optical devices using alternating layers of various III-V compound semiconductors, it is necessary to study them deeply. Therefore, the main objectives of the work presented in this thesis are:

1. Study of electronic band structures of various III-V semiconductor binary and ternary compounds such as - GaN, AlGaN, InN, AlInN and GaInN etc.
2. Modeling of multilayer nano-heterostructures of III-V semiconducting binary and ternary compounds such as;
    a) GaN/AlGaN
    b) InN/AlInN
    c) InN/GaInN.
3. Simulation of
    a) Energy band structure
    b) Potential distribution
    c) Electron density
    d) Hole density
    e) Space charge density
    f) Strain at the interface of heterojunctions.

for the models of multilayer nano-heterostructures of GaN/AlGaN, InN/AlInN and InN/GaInN.

In this thesis, we have studied the properties of multilayer nano-heterostructures of GaN/AlGaN, InN/AlInN and InN/GaInN because, Gallium Nitride (GaN), Aluminium Nitride (AlN) and Indium Nitride (InN) with related alloys forms an interesting class of wide bandgap materials. These materials find special usage in optronics as well as in electronics due to the fact that the entire spectral region from UV to red can be covered with III-N optical devices. These materials form a continuous alloy system made up of Gallium Indium Nitride (GaInN), Aluminium Indium Nitride (AlInN), and Aluminium Gallium Nitride (AlGaN) whose direct optical bandgaps for the hexagonal Wurtzite phase range from 0.7 eV for InN and 3.4 eV for GaN to 6.2 eV for AlN. This is not possible with III-V material system based on GaAs, AlAs, GaP, InAs and related alloys.