UNIT IV

Optical properties of Materials

4.10.Quantum confined stark effect (QCSE)

In quantum well, the electron and hole wave function are separated and pushed towards opposite sides of well by the applications of electric field.

This results in a shift of absorption spectrum to longer wave length this shift is known as quantum confines stark effect.

Explanation:-

In the absence of electric field, electrons and holes occupy discrete energy state.

When an electric field is applied the electron states shift to lower energies, while the hole states shift to higher energies this reduces light absorption or emission.

When an electric field is applied, electrons and holes are shifted to opposite sides of quantum well. This decreases the overlapping of wave function and reduces the recombination efficiency

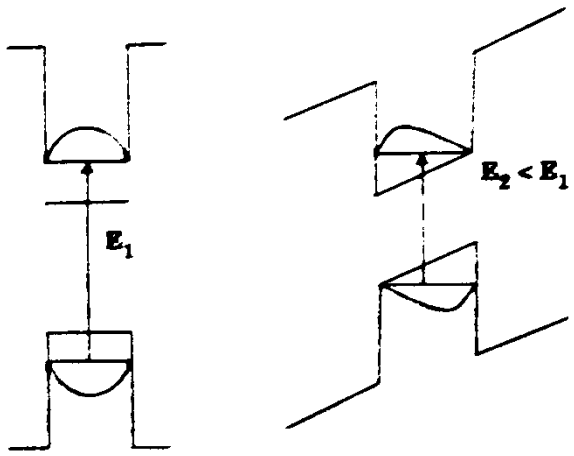


Fig 4.10.1.Quantum confined stark effect

4.11.Quantum dots (QD)

Quantum dots are tiny particles or nano crystals of semiconducting materials with diameters in the range of 2 to 10 nano meters.

4.12.Size effects band gap quantum dot

As the size of the crystal deceases the differencing energy gap between the valance band and conduction band increases.

Thus more energy is leaded to excite the dot. When a crystal return to its ground state more energy is released this results colour shift from red to blue. Thus quantum dots can emit any colour of light from the same material by changing the size of dot.

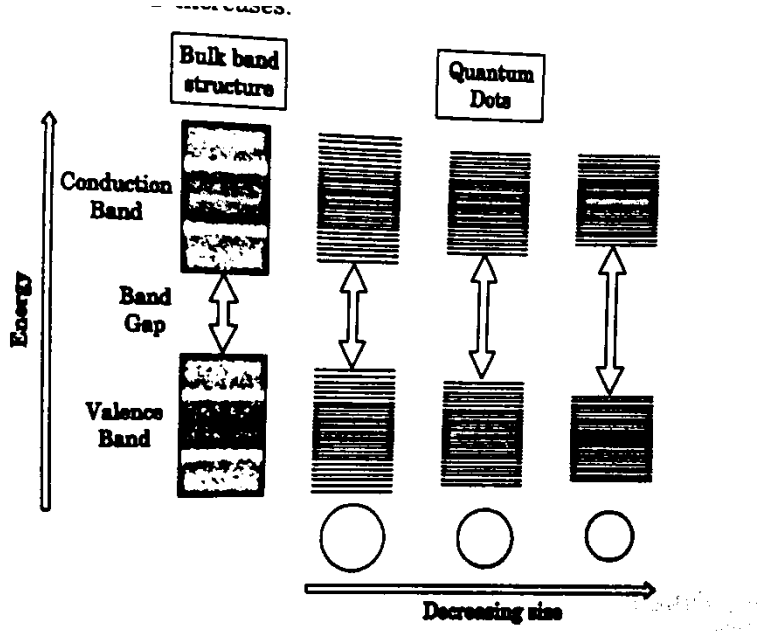


Fig 4.12.1 Band gap of Quantum dot

4.13.Quantum dot laser

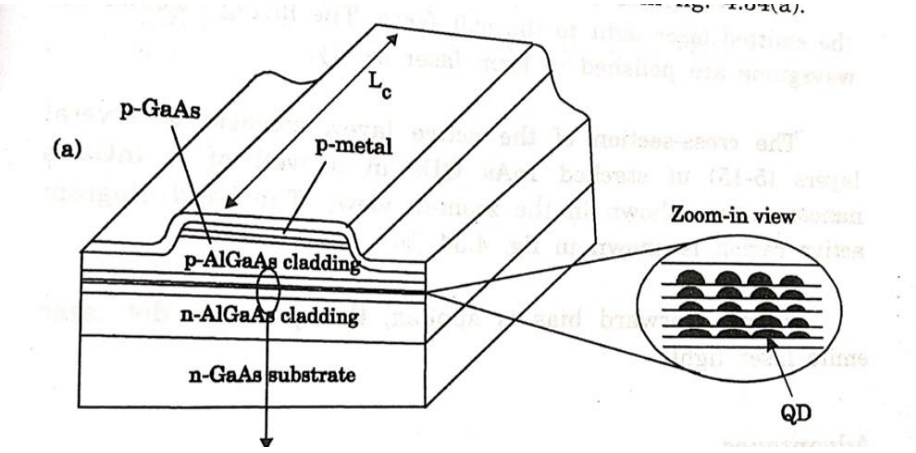
Quantum dot laser is a new generation semiconductor laser which consists of millions of quantum dots in their active region

Principle:-

The active layer consists of quantum well or quantum dots whose band gap is very lower than that of surrounding medium.

The wave length of laser is determined by the energy levels of quantum dots.

The emission wave length can be tuned by changing the size of the dots.



Construction:

The structure is grown on a n type Ga-As substrate which serves as the lower contact to the device.

The active layer is formed using InGaAs with the inclusion of InAs dots. The active layer is placed between n and p type AlGaAs. This forms p-i-n structure.

After forming this three layers a p-GaAs layer is grown on GaAs substrate. The metal contact is deposited on p type GaAs.

Working:

When this p-i-n structure is forward biased a laser light is emitted from the active region. The wavelength of light is determined by the energy levels of quantum dots.