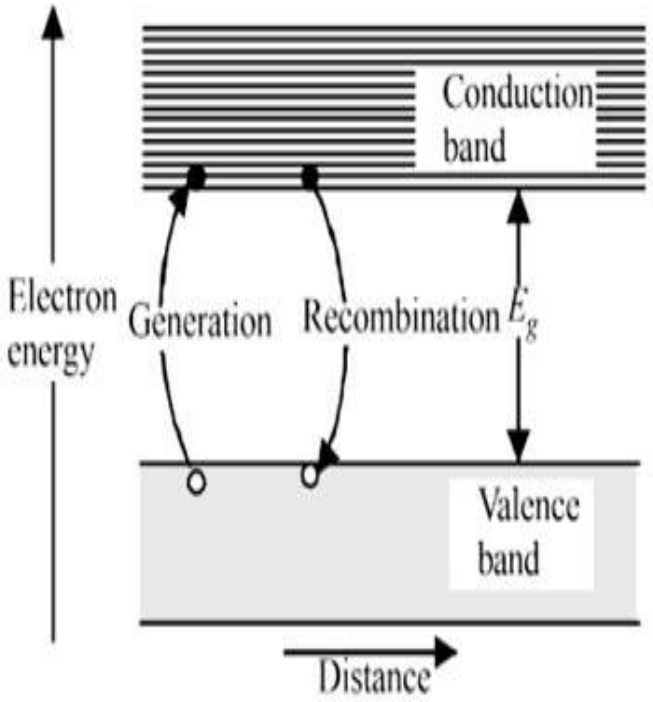
UNIT-III

Optoelectronics

Generation and recombination of carriers

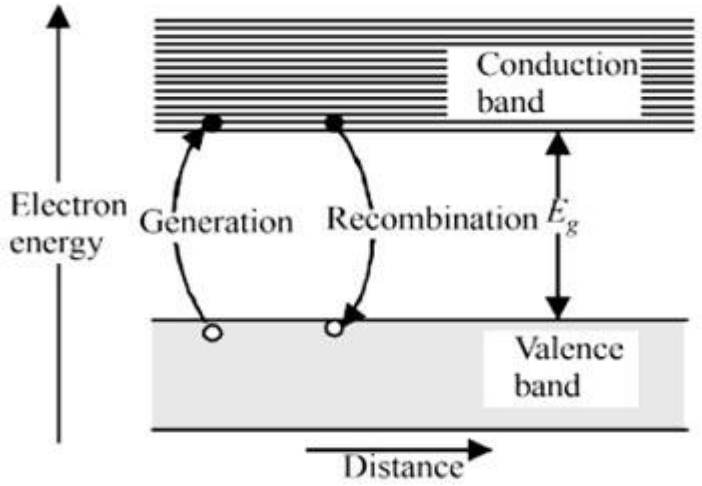
Generation and recombination of carriers

- Generation of carriers (free electrons and holes)
- The process by which free electrons and holes are generated in pair is called generation of carriers.
- When electrons in a valence band get enough energy, then they will absorb this energy and jumps into the conduction band. The electron which is jumped into a conduction band is called free electron and the place from where electron left is called hole. Likewise, two type of charge carriers (free electrons and holes) gets generated.



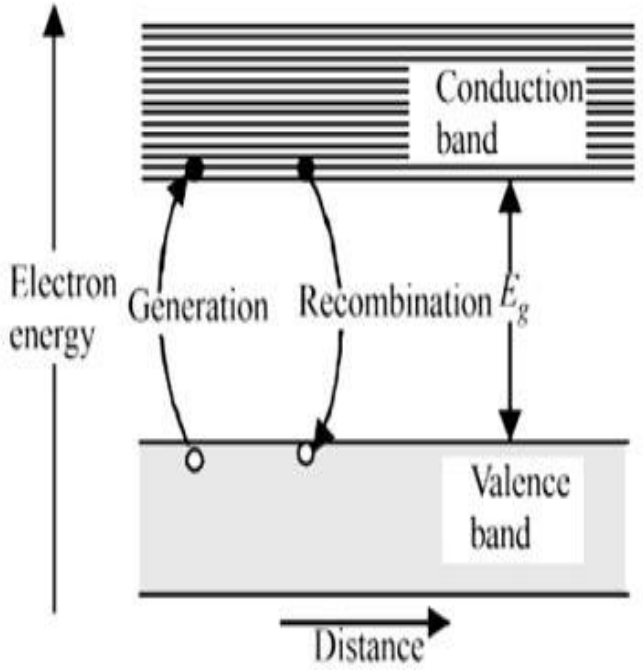
Generation and recombination of electron-hole pairs

- Recombination of carriers (free electrons and holes)
- The process by which free electrons and the holes get eliminated is called recombination of carriers. When free electron in the conduction band falls in to a hole in the valence band, then the free electron and hole gets eliminated.



Generation and recombination of electron-hole pairs

- When sufficient energy is given to the semiconducting material, covalent bonds are broken and a pair of electron and hole is generated.
- The electrons are raised from valence band to conduction band. Holes remain in the valence band.
- The process of generation can occur only when the energy given to the semiconducting material is greater than its forbidden energy gap.
- Recombination is the process where an electron from the conduction band recombines with a hole in the valence band. This is called band to band recombination and in the process a photon is released.



Generation and recombination of electron-hole pairs

- Recombination can be classified into following
- Direct recombination
- Indirect recombination

Direct band gap material

The maximum of ***VB*** and the minimum of ***CB*** exists at the same value of wave number Such semiconductors are called ***direct band gap material.***

✔ In this type during the recombination of holes and electron, a ***photon of light*** is released. This process is known as ***radiative*** recombination. Also called as ***spontaneous emission***.

✔ It is more effective, because the direction of motion of electron remains unchanged.

✔ In this type of semiconductors life timeof charge carrier is very less.

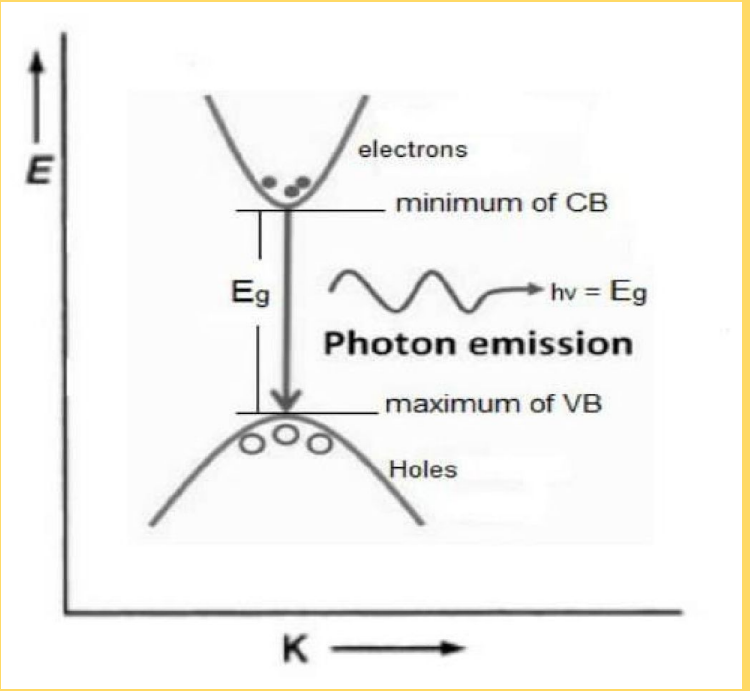
✔ Electron – hole pair can be easily generated because it requires less momentum.

✔ Recombination probability is much high.

✔ These are used to fabricate LEDs and laser diodes.

✔ These are mostly from the compound semiconductors.

Ex: InP, GaAs …….



Indirect band gap material

INDIRECT BAND GAP SEMICONDUCTOR:

- ✔ The maximum value of VB and the minimum value of CB exists at the different values of wave number . Such semiconductors are called Indirect Band Gap Semiconductor.
- ✔ In this type, heat energy is produced during the recombination of holes and electrons. This process is known as non radiative recombination.
- ✔ It is less efficient, because the direction of motion of electron changed.
- ✔ In this type of semiconductors life time of charge carrier is high.
- ✔ The incident process is slower, because it requires an electron, hole and phonon for interaction.
- ✔ Recombination occurs through some defect states.
- ✔ Due to the longer life time of charge carriers, these are used to amplify the signals as in the case of diodes and transistors.
- ✔ □ These are mostly from the elemental semiconductors.
- ✔ Ex:Si ,Ge