

## Optical properties of Materials

### 4.1.Introduction:

The materials which are sensitive to the light are called optical materials.

#### 4.1.1Types of optical materials:

##### 1. Transparent materials:

Materials which allow light with little absorption and reflection are called transparent materials.

Eg:Glass

##### 2.Opaque materials:

Materials which does not allow light through them are called opaque materials.

Eg:Wood

##### 3. Translucent materials:

Materials which allow only small amount of light are called translucent materials.

Eg:Plastic cover

### 4.2.Carrier Generation And Recombination

Definition:The process of creating electron-hole pair is called carrier generation

#### Types:

- Photo generation
- Phonon generation
- Impact ionization

#### Photo Generation

In this Light photon is absorbed by an electron ,then the electron moves from valence band

to conduction band to produce electron hole pair. Figure shows the absorption of light of energy  $h\nu$ . Here the energy of photon is greater than the energy gap of the semiconductor

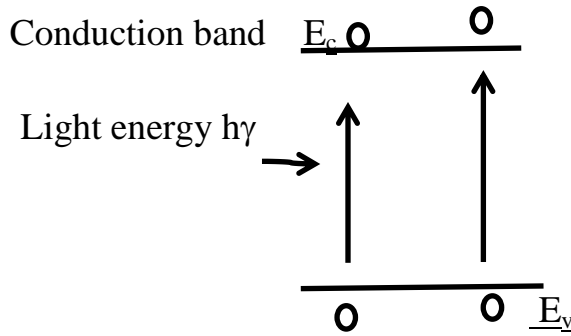


Fig 4.2 .1.Photo Generation

### Phonon Regeneration

When the temperature of the semiconductor is increased, lattice vibration is increased. Then the covalent bond breaks and electron hole pair is created.

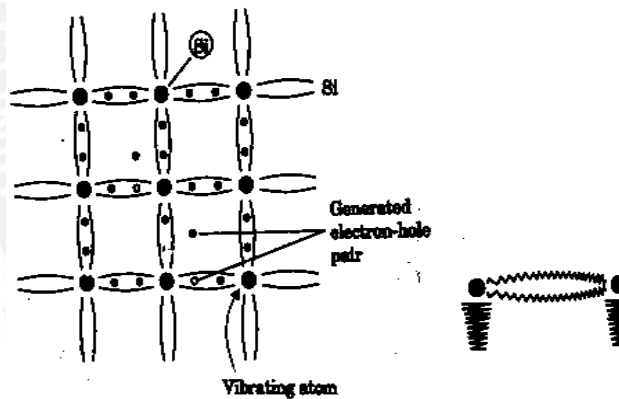


Fig 4.2.2 Phonon Regeneration

### Impact Ionization

When an electric field is applied to a semiconductor an electron gain energy. Then it hits other Si atom to break the covalent bond. Thus electron hole pair is created. For a very high electric field, an avalanche breakdown occurs.

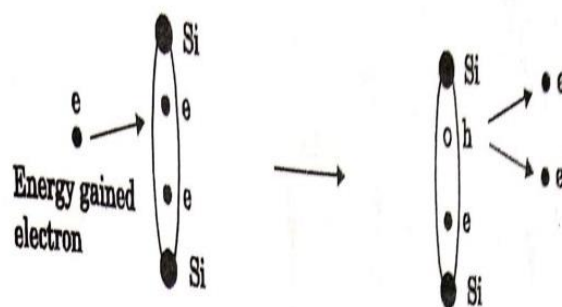


Fig 4.2.3. Impact Ionization

## Carrier Recombination

Definition: When a free electron in the conduction band falls to valence band and recombine with a hole to produce light it is called Recombination.

Types:

- Radiative Recombination
- Shockley read hall Recombination
- Auger Recombination

### Radiative Recombination

Electrons in higher energy states of conduction band will move to lowest level of conduction band by emitting heat. From this lowest level they fall to valence to emit light. This is called direct recombination. It is produced in direct band gap semiconductor. (GaAs)

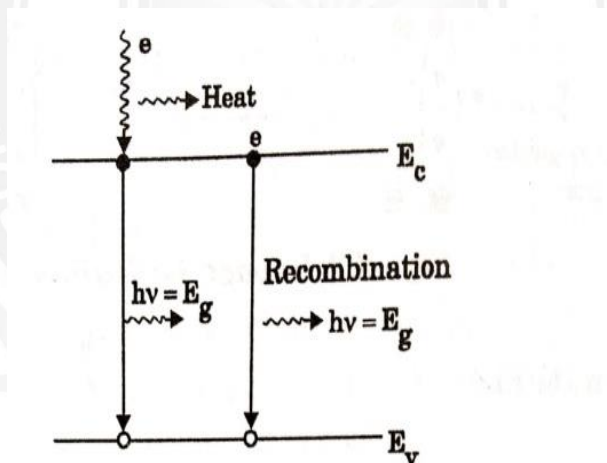


Fig 4.2.4. Radiative Recombination

### Schockley-Read-Hall Recombination

Electrons from conduction band move to intermediate level between  $E_c$  and  $E_v$  by emitting photon or phonon. From this level they move to valence band to emit photon. It is produced in impure semiconductor which has defect.

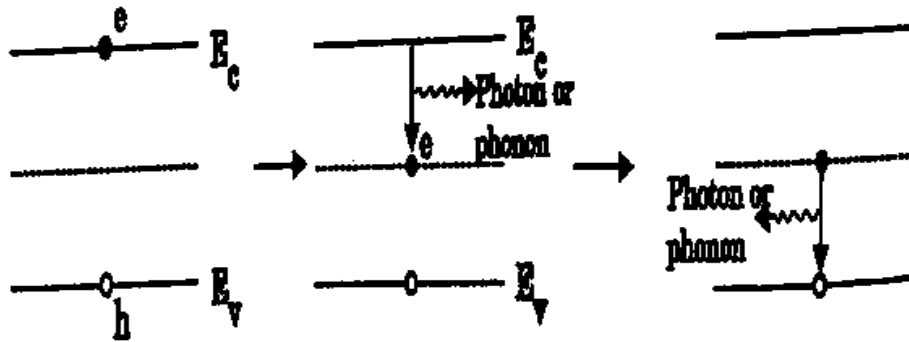


Fig 4.2.5. Shockley-Read-Hall Recombination

**Auger Recombination**

In this, first an electron and hole recombine with each other to produce light. This light is given to an electron in  $E_c$  and it moves to highest level of conduction band. From this it moves to  $E_c$  by emitting heat. Then it returns to  $E_v$  to produce light.

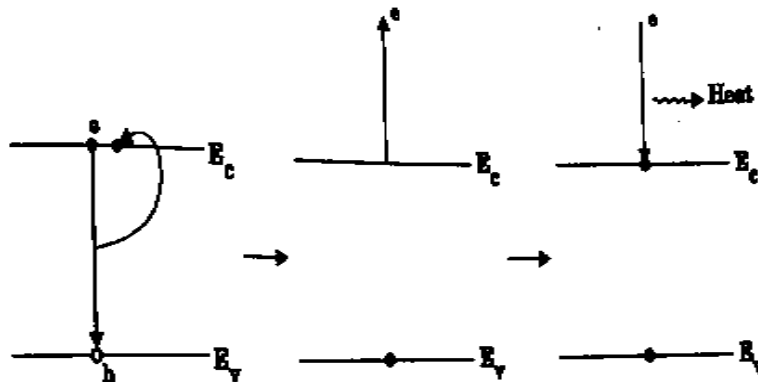


Fig 4.2.6. Auger Recombination