UNIT -III SEMICONDUCTOR PHYSICS

TOPIC – I INTRINSIC SEMICONDUCTOR AND ENERGY BAND DIAGRAM

INTRODUCTION

The materials are classified on the basis of conductivity and resistivity. The resistivity of a semiconductor is in the order of 10^{-4} to 0.5 ohm-metre. A semiconductor is a solid which has the energy band similar to that of an insulator. It acts as an insulator at absolute zero and as a conductor at high temperatures and in the presence of impurities.

PROPERTIES OF SEMICONDUCTOR

1. The resistivity of semiconductors lies between conducting and insulating materials. (i.e.,) 10^{-4} to 0.5 ohm-metre.
2. At 0K they behave as insulators.
3. When the temperature is raised or when impurities are added, their conductivity increases.

   i.e., $\rho \alpha 1/T$
4. They have negative temperature co-efficient of resistances.
5. Total conductivity (σ)= $\sigma_e + \sigma_h$

   Where, σ_e – conductivity due to electrons

   σ_h - Conductivity due to holes
6. They are formed by covalent bond.
7. They have empty conduction band at ok.
8. They have almost filled valence band.
9. They small energy gap.
10. If impurities add in semiconductor, the electrical conductivity increases. When the temperature is increased, electrical conductivity is decreases.

CLASSIFICATION OF SEMICONDUCTORS

There are two types

i. Elemental Semiconductors

ii. Compound Semiconductors

Elemental Semiconductors

Elemental semiconductors are made up of single element and are called as indirect band gap semiconductors. Heat is produced during recombination process. Ex: Ge, Si

Compound semiconductors

Compound semiconductors are made up of compounds and are called as direct band gap semiconductors. Photons are emitted during recombination process.

Ex: GaP, MgO

TYPES OF SEMICONDUCTORS

Based on the purity, semiconductors are classified into the following two types:

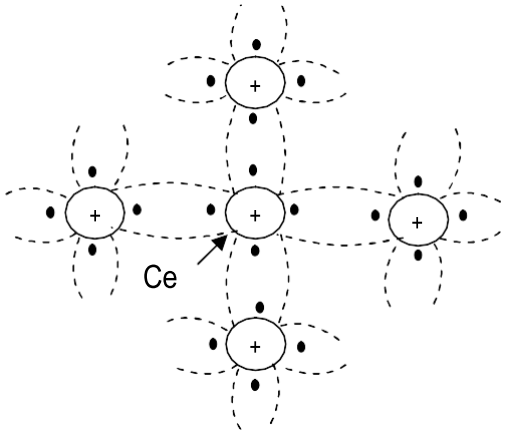
i. Intrinsic semiconductor
ii. Extrinsic semiconductor

INTRINSIC SEMICONDUCTOR

A semiconductor in a extremely pure form is called as intrinsic semiconductors. Ex: Ge, Si

Let us consider two atoms of Germanium brought closer to each other. Now the positive core of one atom interacts with one of the electrons from the other atom and the two electrons are shared by two atoms. These electrons are called Electron Pairs. When the attractive force is balanced, by the repulsive force between the two positive cores, a covalent bond is formed.

Explanation



In the case of Ge or Si we have 4 valence electrons.

It is the tendency of each germanium atom to have 8 electrons in the outer most shell.

To do so, each germanium atom arranges itself between four other germanium atoms asshown in fig.

Here neighbouring atoms share one valence electron with the central atom.

So, by this sharing, the central atom completes its last orbit by having 8 electrons.

Hence all the four valence electrons of the central atom gets tightly bound to the nucleus.

Similar such bonding occurs among all the other atoms giving rise to extremely stable structure and hence has low conductivity.

In these semiconductors the electrons and holes can be created only by thermal agitation.

As there are no impurities the number of free electrons must be equal to the number of holes.