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SEMI CONDUCTORS DEVICES-A DESCRIPTIVE ANALYSIS

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ABSTRACT

The electrical properties of a crystalline solid can be easily explained on the basis of energy band theory of solids. A solid can be placed in one of the three categories i.e. Metals, insulators, and semiconductor. The conductivity of semi conductors lies between metals and insulators. Conductivity of solid depends upon mobility of current carriers and number density of current carriers. Conductivity charges with change in the temperature. Semi conductors are of two types : intrinsic semi-conductor and external semi-conductor make by using doping process. Doping with different impurity make different type of semi conductors and P type and N type semi-conductor. With the combining of P-And N type P-N Junction formed. And in biasing process on external potential difference is applied across P-N junction.

Key Words: Conductivity, Crystal, Doping, Semi-Conductor, P-N Junction,

I INTRODUCTION

Now-a-days all the electronic devices which we use are based on the controlled flow of electrons. In 1930, it was realized that some solid state semi-conductors and their junctions can be helpful of controlling the number and direction of flow of charge carriers through them. The discovery of semi-conductor junction, i.e. junction diodes and transistors, replaced the vacuum tubes as they are small in size operate at low voltage, consume small power, having long life and high reliability.

The semiconductor junctions led to the discovery of integrated circuits which have revolutionized the electronic industry as they have been used in the working of television and computer which are very commonly used in our daily life.

The solid on the basis of conductivity mainly of three types

a) Metal conductor
b) Insulator
c) Semi-conductor

On the basis of relative values of electrical conductivity and resistivity, the solids can be classified. The solids which have high conductivity and low resistivity are called semi-conductors.

Semi-conductor can be also classified on the basis of purity. If a semi-conductor is pure semiconductor which is free of every impurity is called intrinsic semi-conductor. The electrical conductivity of a pure semi-conductor is totally governed by the number of electrons excited from the valence band to conduction band and is called intrinsic conductivity. A semi-conductor with suitable impurity atom added to if called extrinsic semi-conductor. Extrinsic semi-conductors are of two types.

1. n-type semi conductor
2. p-type semi conductor

II OBJECTIVES OF THE STUDY

The study was focused towards achieving the following objectives:

- To measure the Electrical conductivity of Semi-conductor.
- To examine the Biasing of the P-N Junction.
- Characteristics of a P-N Junction Diode

III THEORY

Intrinsic and Extrinsic Semi conductors

A pure Semi-conductor which is free from every impurity is called intrinsic semi-conductor. The conductivity of a pure semiconductor at room temperature is very small due to small number of free electrons and holes.

The semi-conductor formed due to doping process in which we added some impurities are called impurity – conductor or extrinsic semi-conductors. The impurity atoms are thus either trivalent or penta-valent, while the semi-conductor is tetra valent. The impurities which should be added are elements belonging either to third group or to the fifth group of the periodic table.

3.1 P and N Type SEMI CONDUCTOR

When the impurity atoms are pentavalent from the fifth group the extrinsic semiconductor is called N-type semi-conductor. Example is impurity of arsenic is being added to germanium. Four electrons of arsenic atom enter into covalent bonds with germanium atoms. Fifth electron is loosely bonds with germanium atoms. The majority charge carrier in N-Type semi conductor is electrons.

Is the impurity atoms added in a tetra valent semi-conductors is tri-valent. The semi-conductor is called P-type Semi-conductor.

On addition of boron impurity in germanium, the germanium atoms equal in number of boron are replaced. Three boron atoms form co-valent bonds with germanium atoms. One covalent bonds around a boron atom has an electron missing. This electron deficiency is called a hole. And In P-Type semi-conductor majority charge carrier is holes.

3.2 FORMATION OF P-N JUNCTION

When a P-type extrinsic semi-conductor is in intimate contact with N-type material a P-N Junction is formed. We cannot produce such a junction by merely placing N-type and P-Type semi-conductor in conduct with each other. Because of discontinuity of lattice structure of the junction. The usual method of achieving such type of structure is by treating one end of a single N-type crystal with a acceptor impurity.

3.3 BAISING OF A P-N JUNCTION

An external potential difference can be applied across a P-N junction in following two ways

(i) Forwarding biasing

If an external battery is connected across the P-N junction with its positive terminal to P-region and negative terminal to N-region.

(ii) Reverse biasing

In the reverse biasing, P-Type region is connected with the negative terminal of the battery and N-type region with the Positive terminal

IV RESULTS & DISCUSSION

4.1 Electrical conductivity of semi-conductors

The conductivity of a solid depends upon two factors

a) Mobility of current carriers
b) Number density of current carriers

As temperature increases, the mobility of current carriers' electron and holes in a semi conductor decreases, similar to the decrease in mobility of electrons in metals. But with the rise in temperature more and more electrons cross over the forbidden energy gap and jump from valance band into conduction Band. This increases the number densities of electrons and holes. The increase in number density is so large that the conductivity increases with the rise in temperature in spite of decrease in mobility of current carriers.

4.2 Characteristics of forward and Reverse Biasing

(a) In forward biasing the P-N junction connected as Positive terminal of battery to P-region and negative terminal to N-region. At this stage the potential barrier is considerably lowered. The depletion layer also decreases and finally disappears. For this voltage applied across the diode must exceed the potential barrier and called forward biasing voltage. Free electrons N region can easily cross to P-region and holes from P-region move towards N-region. Thus a large current will flow through the junction and a very small resistance to flow of current.

(b) In Reverse biasing the P-N junction connected as positive terminal of battery to N-region and negative terminal to P-region. At this stage the potential barriers is considerably highly. The depletion layer also increases; resulting in the increase in the potential barrier majority charge carriers cannot cross the P-N junction. A very low current will flow due to minority charger carriers.

4.3 Characteristics of a P-N Junction

In P-N Junction P-region is called anode and its N-region is called Cathode. During the forward bias, the junction does not conduct until the external or forward voltage overcomes the potential barrier. The voltage at which the current begins to increase sharply is called knee-voltage (V_0) for germanium $V_0 = 0.3V$, while for silicon its value is 0.7V. In reverse bias, the current is very small and remains almost constant for all voltages less than break down voltage.

It can be shown that

$$I = I_0\left[\exp.\left(\frac{V}{nV_T}\right)-1\right]$$

Where I_0 is the reverse saturation current, V is potential difference across P.N Junction and V_T is known as volt equivalent of Temperature. Here

$$V_T = \frac{kT}{e}$$

$$I = I_0\left[\exp.\left(\frac{e}{nk_T}\right)-1\right]$$

The above relation is known as voltage current equation of a P-N junction.

V CONCLUSION

The conductivity of a semi-conductor can be greatly increased, if it is doped with a small quantity of suitable impurity. And the mobility of holes and electrons decreases with the rise in the temperature. The Increase in the conductivity of semi-conductors with the rise in temperature is mainly due to increase in carrier concentration with rise in temperature. At the low temperature a pure semi-conductor, believe as an insulator. It has small conductivity at room-temperature. There are two types of doped semi-conductors: N-type and P-Type. In N-type electrons are majority carriers and holes are minority carriers. IN P-type holes are majority carriers, while electrons are minority carriers. For making N-Type semiconductor doping pure semiconductor with controlled amount of penta-valent impurity atoms like arsenic antimony and for P-Type doping with Indian boron etc.

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