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Review on Development in Semiconductors in Electronics

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ABSTRACT

In the present paper, we would like to discuss about a vital role of semiconductors in development of electronics. In this paper we have reviewed on semiconductor material, bang gap energy, how temperature is affecting on working of semiconductor devices in electronics. Formation and application of different diodes and development of electronics explained briefly.

Keywords: Semiconductor, band gap, conductivity.

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INTRODUCTION

Electronic is the field of engineering which deals with controlled flow of electrons through vacuums, gases, semiconductors and metals. Some materials are good conductors of electricity such as copper, silver, gold, aluminum etc. There conduction band and Valence band are overlap with each other as shown in Figure 1.

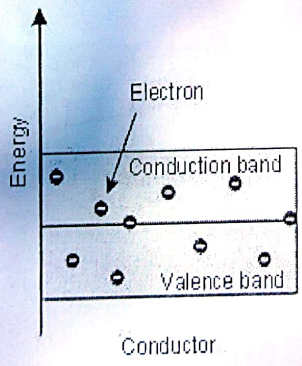

Fig. 1. Energy band gap of conductor.

While some materials are bad conductors of electricity such as wood, glass, fiber, Bakelite etc. There is a band gap between conduction band and Valence band more than 3 eV as shown in Figure 2.

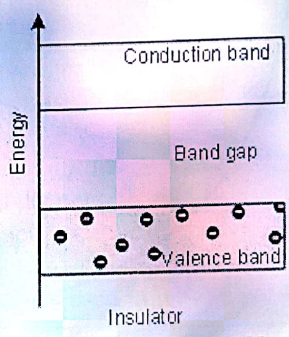

Fig. 2. Energy band gap of Insulator.

There are some materials which neither good conductors, nor bad conductors those are called as semiconductors such as germanium, silicon etc. There is band gap between conduction band and Valence band less than 3 eV as shown in Figure 3. After increasing the temperature, the free electrons in the valence band crosses the band gap energy and enter into the conduction band. Therefore, its conductivity increases as temperature increases and resistivity decreases. This property is used for construction of semiconductor components.

Conductivity of those materials is depending on room temperature. Because

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of this property semiconductor is used for making electronic components. As temperature goes on increasing the conductivity goes on increasing. This shows that such material has negative temperature coefficient. Such a nature of graph is shown below in Figure 4.

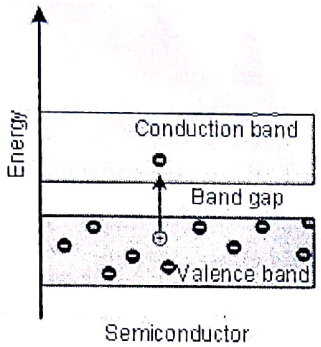

Fig. 3. Energy band gap of semiconductor.

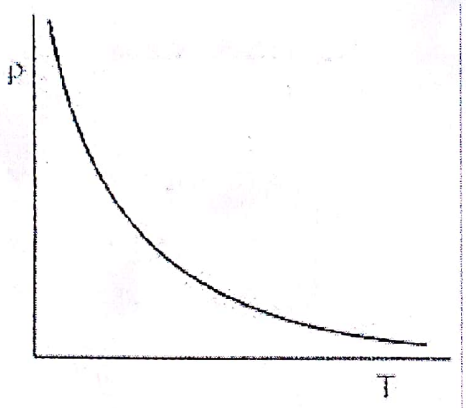

Fig. 4. Graph showing the temperature and conductivity.

From above graph, it is clear that as temperature increases the resistance of material decreases exponentially. Therefore, the conductivity goes on increasing. The increasing conductivity causes the resistivity of the semiconductor material to decrease with the rise in temperature, resulting in a negative temperature coefficient of resistance.

In the pure semiconducting material impurity is very small i.e. 1 part of 10^{10} Such material is known as intrinsic semiconductor. After adding impurities it became extrinsic semiconductor. The process of adding impurities is known as doping. Purpose of doping impurities is to increase either number of free electrons or holes for desire result from semiconductor component. Impurities are of two types' pentavalent impurity and trivalent impurity. If pentavalent impurities doped to intrinsic semiconductor excess numbers of electrons are produced. If trivalent impurities doped to intrinsic semiconductor excess numbers of holes are created. Based on doping impurities semiconductor materials are classified into two types n-type semiconductor p-type semiconductor (Figure 6). Pentavalent impurity gives n-type semiconductor while trivalent impurities give p-type semiconductor.

Doping pentavalent impurity in this process each impurity atom donates it's 5^{th} electron to conduction band to act as a free electron hence this impurity is called as donor impurity. These donated electrons are much large in number as compare to thermally generated electron hole pair (by breaking of covalent bond). In n-type semiconductor numbers of free electrons are greater than number of holes hence electrons are majority carrier and holes are minority carrier (Figure 5).

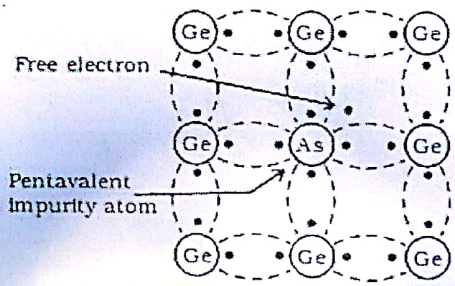

Fig. 5. Formation of n-type semiconductor.

Doping trivalent impurity an atom has three valence electrons in its valence band. These three electrons formed covalent bonds with the three neighboring semiconductor atoms. The forth

neighboring semiconductor atom is unable to form a covalent with the impure atom, as impure atom does not have fourth electron in its valance orbit. Thus, there is deficiency of electron around the impure atom. This deficiency of electron is termed as 'Hole'.

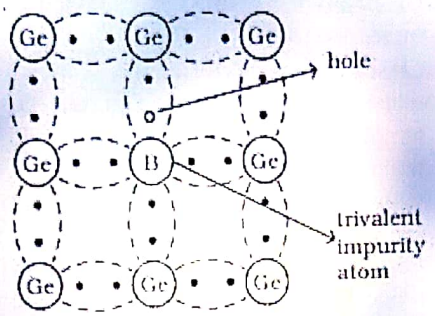

Fig. 6. Formation of p-type semiconductor.

Due to tendency of the incomplete bond to complete itself, it snatches on electron from adjacent covalent bond to occupy the vacant position. This creates a hole at the position from where the valence electron jumped. Second thing is incomplete covalent bond is completed due to the valence electron filling it. Thus, large numbers of holes are created due to addition of small amount of trivalent impurity. Those holes are ready to accept the electrons; hence the impurity is called as acceptor impurity.

n-type and p-type semiconductors are used to construct number of semiconductor (active) components such as diode, transistor, etc.

A p-n junction ***Diode*** is one of the basic active components. It is two element components has two terminals anode and cathode, it is possible to construct a p-n junction on a single piece of semiconductor as shown in Figure 7.

There are different types of diodes available according to construction and use.

General diode is a component which converts alternating current (ac) into direct current (dc). Generally, diodes are used in rectifier circuits rectification process is one of the fundamental signal functioning process in Electronics. It is also used in chopper circuit, detector circuit, reverse current protector circuit.

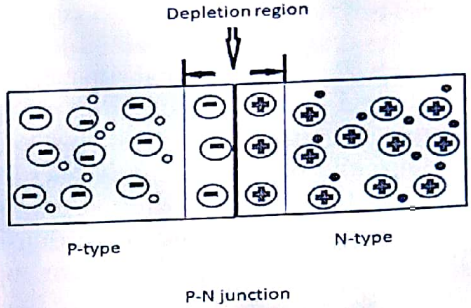

Fig. 7. Formation of p-n junction.

Zener diode is used in regulated power supply circuits.

Light Emitting Diode (LED), LEDs are used as indicators, in different display, in power supply as indication of on or off.

Laser diode is used in remote control, it is also used in medical equipments, laser shows etc.

Photo diodes are used in light sensor circuits.

The second important basic semiconductor component in Electronics is ***Transistor***. It is three element component has three terminals emitter, base and collector. Basically, it is used to increase power of any signal. Amplification is second important fundamental signal functioning process in Electronics. For amplification transistor is used it is also used in Electronic switch, different circuits. Thus, diodes and transistors are basic important semiconductor components used in Electronics circuits. Because of next development in manufacturing of semiconductor components, and it is

construction of ***Integrated circuits*** (IC) using large scale integration (LSI) and very large-scale integration (VLSI) technique. Components constructed by using that technique is integrated circuits (IC) and microprocessor. In IC number of diodes, transistors etc. are constructed on a single semiconductor chip. There are number of integrated circuits (IC) used in Electronics circuits, from which some popular ICs are. ***IC 74 series*** are used for digital gates in digital Electronics circuits.

Op-amp IC 741 is used for number of operational amplifier circuits in which op-amp as inverting amplifier and op-amp as non-inverting amplifier those are the basic circuits. Other circuits are op-amp as adder, op-amp as substractor, op-amp as integrator, op-amp as differentiator, op-amp as comparator etc.

IC 555 is a timer IC used in various timer circuits, like as-table timer (as-table multivibrator), bi-stable timer bi-stable multivibrator), mono-stable timer (mono-stable multivibrator), FSK modem etc.

Memory chips in some instruments memory is require lick computer, for this semiconductor memories are used those are Random asses memory (RAM), Read only memory (ROM), Programmable Read only memory (PROM) Erasable Programmable Read only memory (EPROM) etc.

While in microprocessor (μp) by using LSI or VLSI technique thousands or millions of components are constructed on a single semiconductor chip. Some microprocessors applications are ***Microprocessor mother board*** it is main board in computer. ***Microprocessors*** are used in different control programmable systems in industries. ***Microprocessors*** are also used in programmable Robots.

Microprocessor is used in mobile phone. Because of development of LSI and VLSI technique in semiconductor components Electronics systems, devices or instruments are became very comfort to use. Everyone can handle them easily or with some information. Hence because of semiconductor material growth in Electronics industry is faster than another.

CONCLUSION

In this paper we have discussed widely on semiconductor material and its behaviour in rising the temperature. The conductivity goes on increasing as the temperature increases. The increasing conductivity causes the resistivity of the semiconductor material to decrease with the rise in temperature, resulting in a negative temperature coefficient. This gives us temperature is affecting on working of semiconductor devices in electronics. Formation and application of different diodes explained briefly. Transistors are plays key role in the development of electronics. Electronics systems, devices or instruments are becoming very comfort to use due to development of LSI and VLSI technique in semiconductor components.

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