COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

Electronics

CTE 207

Lecture 3

- Diode Equivalent Circuit -

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Types of semiconductors

- A semiconductor is a material that has a conductivity level some-where between the extremes of an insulator and a conductor.

- The following equation derived from the basic resistance equation :

$$\rho = \frac{RA}{L} = \frac{\Omega(cm^2)}{cm} = \Omega - cm$$

Types of semiconductors

- A pure form of semiconductor is called an intrinsic semiconductor.

- A doping form of semiconductor is called an extrinsic semiconductor.

- In a pure semiconductor, the number of holes is equal to the number of free electrons.

Types of semiconductors

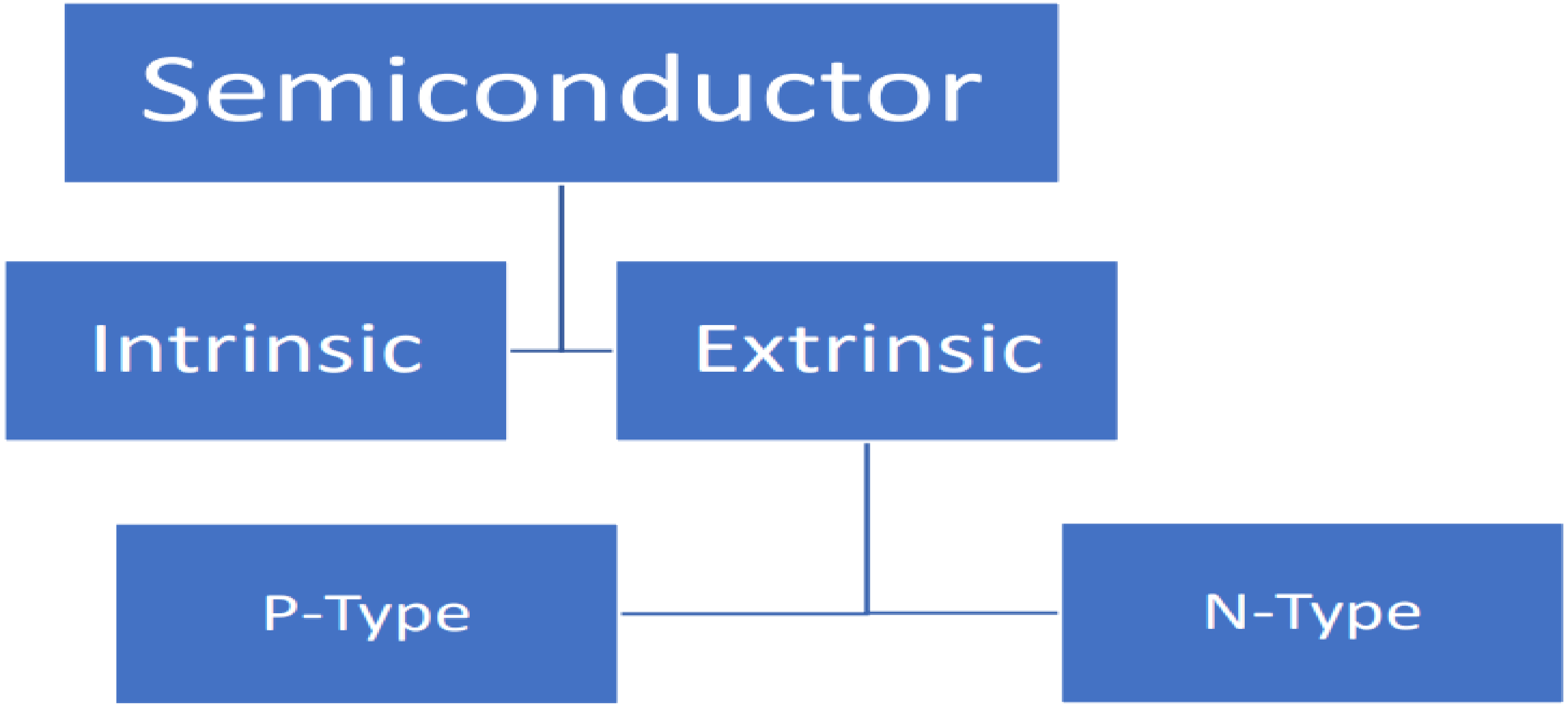

Figure 1: Types of Semiconductors

Intrinsic

Intrinsic materials are those semiconductors that have been carefully refined to reduce the impurities to a very low level essentially as pure as can be made available through modern technology.

- The free electrons in the material due to natural causes are referred to as intrinsic carriers.

- An increase in temperature of a semiconductor can result in a substantial increase in the number of free electrons in the material.

Extrinsic

A semiconductor material that has been subjected to the doping process is called an extrinsic material.

- Doping: is a process where impurities are added to the semiconductor to lower its resistivity.

- Addition atoms which have a different number of valence shell electrons 3 or 5 to a piece of silicon to build P-Type or N-Type silicon structure, respectively.

N-Type and P-Type Semiconductors

- Semiconductive materials do not conduct current well and are of little value in their intrinsic state.
- This is because of the limited number of free electrons in the conduction band and holes in the valence band.
- Intrinsic semiconductors must be modified by increasing the free electrons and holes to increase its conductivity and make it useful in electronic devices.
- This is done by adding impurities to the intrinsic material.

N-Type and P-Type Semiconductors

- Two types of extrinsic (impure) semiconductive materials, n-type and p-type, are the key building blocks for all types of electronic devices.

- Doping the conductivities of semiconductors can be drastically increased and controlled by the addition of impurities to the intrinsic (pure) semiconductive material.

- This process, called doping, increases the number of current carriers (electrons or holes).

N-Type Semiconductor

- To increase the number of conduction-band electrons in intrinsic silicon, pentavalent impurity atoms are added.

- These are atoms with five valence electrons, and are known as donor atoms because they provide an extra electron to the semiconductor's crystal structure.

- This extra electron becomes a conduction electron because it is not attached to any atom.

N-Type Semiconductor

- The number of conduction electrons can be controlled by the number of impurity atoms added to the silicon.

- Since most of the current carriers are electrons, silicon doped in this way is an n-type semiconductor.

- The majority carriers are the excess electrons as shown in Fig. 2.

N-Type Semiconductor

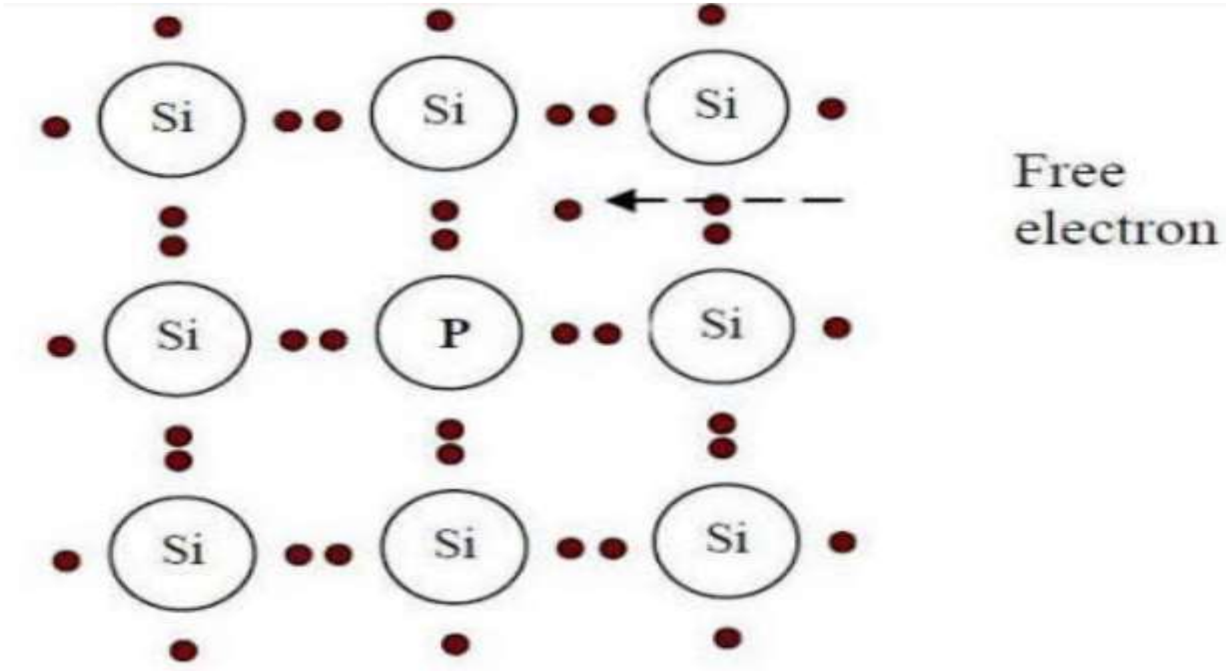

Fig 2. N-Type Semiconductor

P-Type Semiconductor

- To increase the number of holes in intrinsic silicon, trivalent impurity atoms are added.

- These are atoms with three valence electrons, and are known as acceptor atoms because they leave a hole in the semiconductor’s crystal structure.

- A hole is the lack of an electron in the valence shell.

P-Type Semiconductor

- The number of holes can be controlled by the amount of trivalent impurity added to the silicon.

- Since most of the current carriers are holes, silicon doped with trivalent atoms is a p-type semiconductor.

- The majority carriers are "holes" and the minority carriers are electrons as shown in Fig. 3.

P-Type Semiconductor

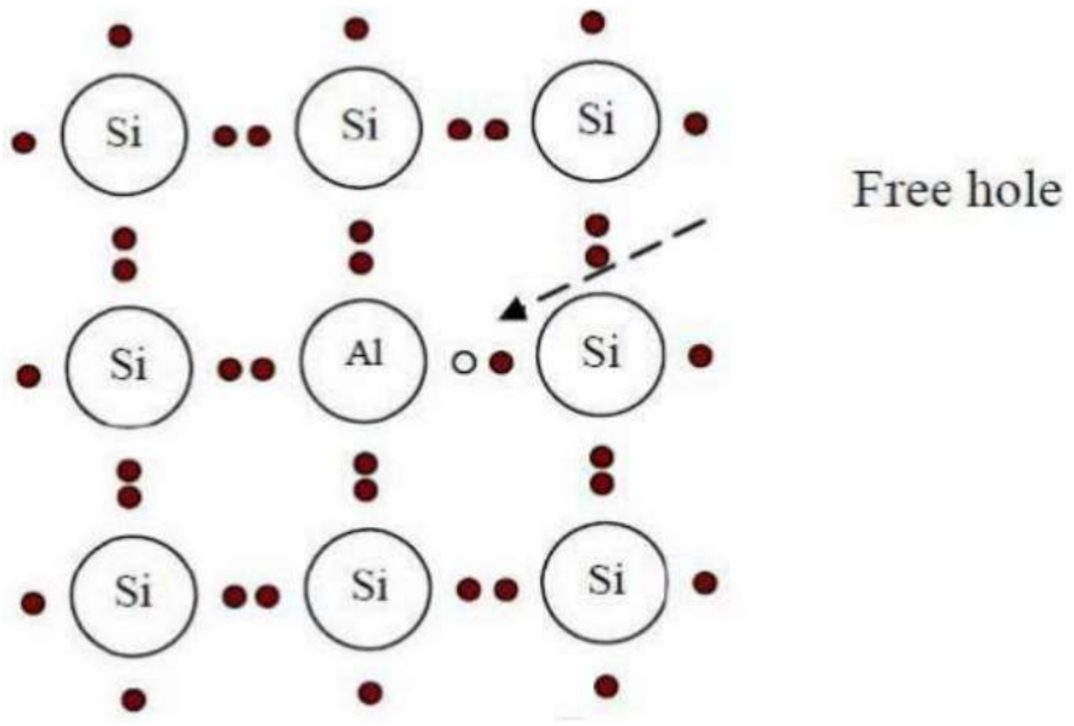

Fig 3. p-Type Semiconductor