



TOPIC:

# GENERAL PROPERTIES OF SEMICONDUCTORS

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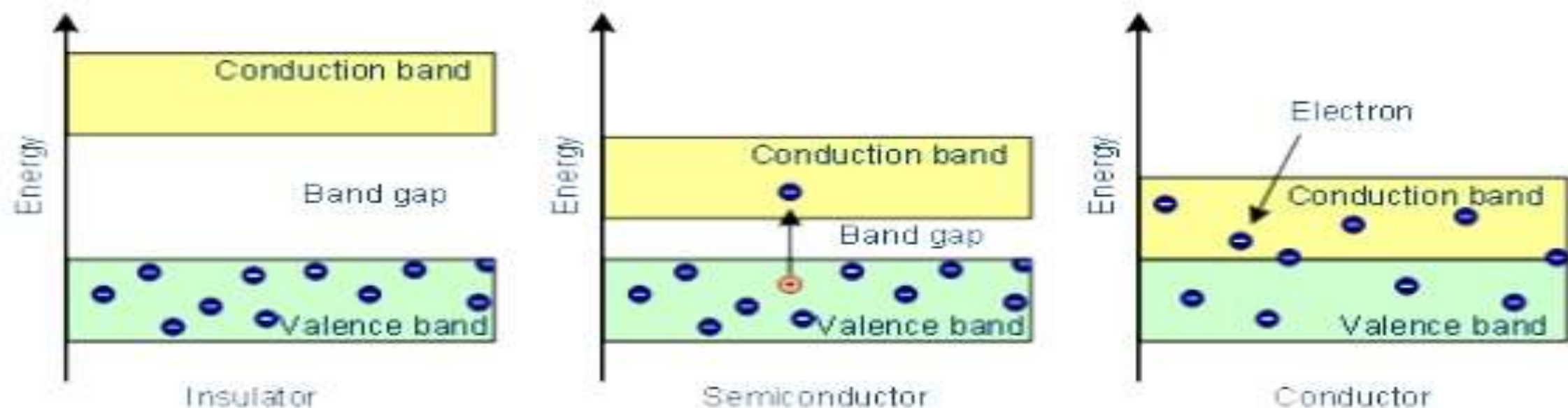
# Energy Band

- In any material, there are 2 energy band:
  1. **Valence band** : the outermost shell that determines the conductivity
  2. **Conduction band** : the band outside the valence shell.

The 2 bands are separated by one energy gap called – **forbidden gap**.

- The valence band contains with electrons.
- The electrons can move to the conduction band if it have enough energy ( eg: light or heat).
- When the electron absorbs enough energy to jump from valence band to the conduction band, the electron is said to be in excited state.

- The concept of energy bands is particularly important in classifying materials as conductors, semiconductors, and insulators.



- **Semiconductor** : has a **smaller forbidden band** and requires less energy to move an electron from the valence band to the conduction band.

- Therefore, for a certain amount of applied voltage, more current will flow in the semiconductor than in the insulator.





- semiconducting elements:


- low electrical conductivity at room temperature
- Electrical conductivity increases with temp.


- Gap between valence and conduction band is intermediate in size.

- Semiconducting elements form the basis of solid state electronic devices.

- Metalloids (such as silicon or germanium) are semiconducting elements whose electrical conductivity increases as temperature increases.

- A striking property of these elements is that their conductivities increase markedly when they are doped with small quantities of other elements.

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- Made from materials that have **four valence electrons** in their outer orbitals.
  - Germanium and silicon are the most common.
  - Silicon is preferred due to its ability to withstand heat.
  - A pure semiconductor material such as silicon or germanium has no special properties and will make a poor conductive material.

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- When silicon is doped with phosphorus, it becomes an **n-type semiconductor**, in which electrical current is carried by negatively charged electrons.
  - When silicon is doped with boron, it becomes a **p-type semiconductor**, in which an electrical current is carried by positively charged holes.
  - Joining a p-type semiconductor to an n-type semiconductor produces a **p-n junction**, which can function as a rectifier.
  - A rectifier is a device that allows current to flow in one direction, but not the other.

## **:Types of Semiconductor**

- Semiconductors are mainly classified into two categories:
  - i. Intrinsic**
  - ii. Extrinsic**
- i. Intrinsic** : chemically very pure and possesses poor conductivity.
  - It has equal numbers of negative carriers (electrons) and positive carriers (holes).
  - Impurities do not affect its electrical behavior.

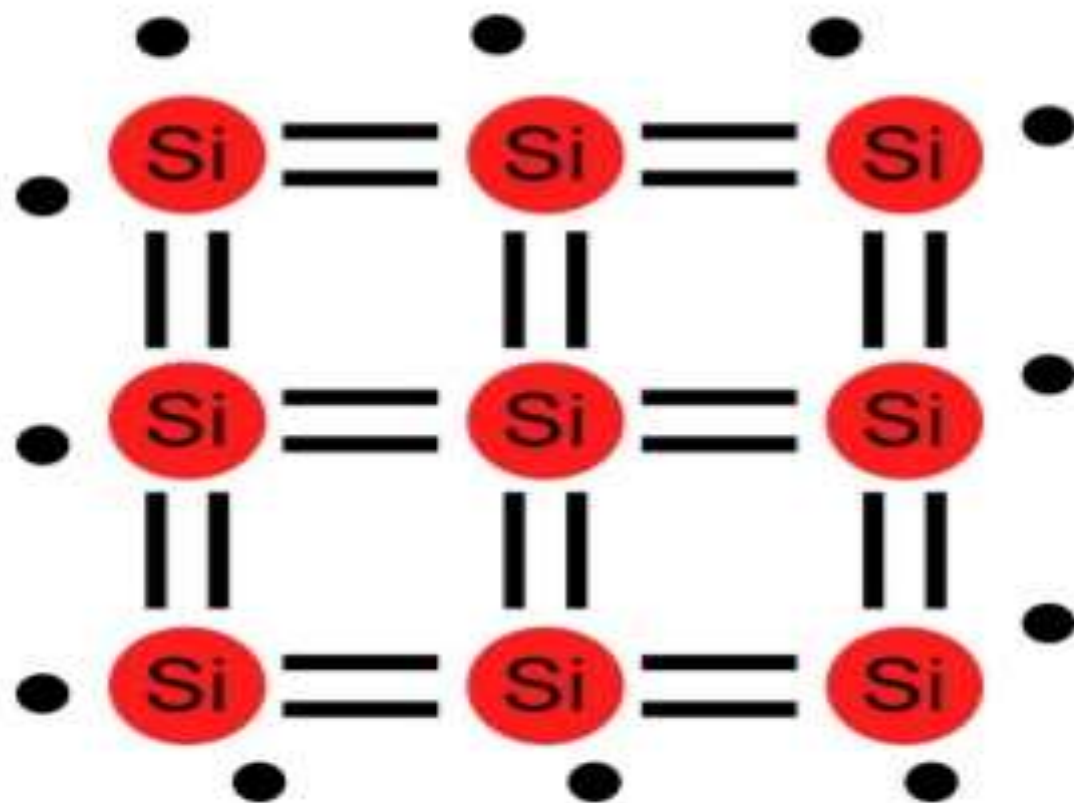


# Intrinsic Semiconductor

Silicon has 4 outer shell  
valence electrons



Forms into **a lattice structure** to share electrons




The pure semiconductor material without impurities atoms.  
example: Silicon and Germanium



## Extrinsic semiconductor :

- improved intrinsic semiconductor with a small amount of impurities added by a process, known as **doping process**, which alters the electrical properties of the semiconductor and improves its conductivity.
- Introducing impurities into the semiconductor materials (doping process) can control their **conductivity**.

- Adding impurities atom into intrinsic semiconductor = extrinsic semiconductor.
- The process of adding specific types of atoms to a semiconductor to favorably alter electric characteristics – **Doping**
- 2 types of extrinsic (impure) semiconductor;
  - ❖ **N-type**
  - ❖ **P-type**

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- When an impurity increases the number of free electrons, the doped semiconductor is **negative or n-type**.
  
  - An impurity that reduces the number of free electrons, causing more holes, creates a **positive or p-type semiconductor**.



# Doping

- **Doping** : Adding impurities to the silicon crystal lattice to increase the number of carriers.
- Add a small number of atoms to increase either the number of electrons or holes.

Thank  
You!

