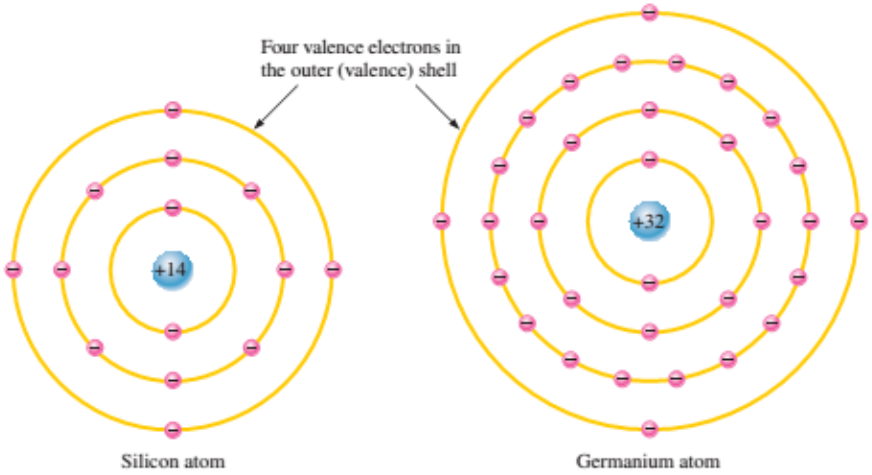
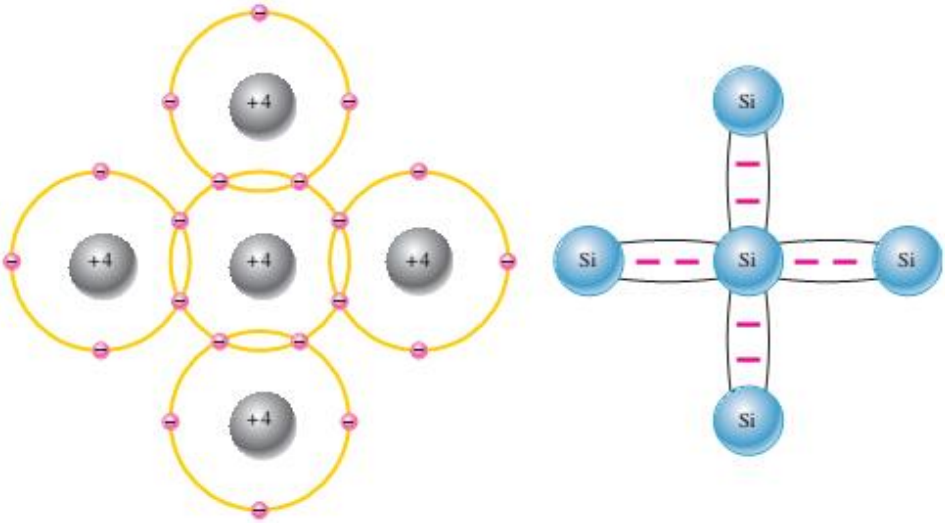
Chapter One : Semiconductor Materials and pn Junctions

1-1 Silicon and Germanium Atoms



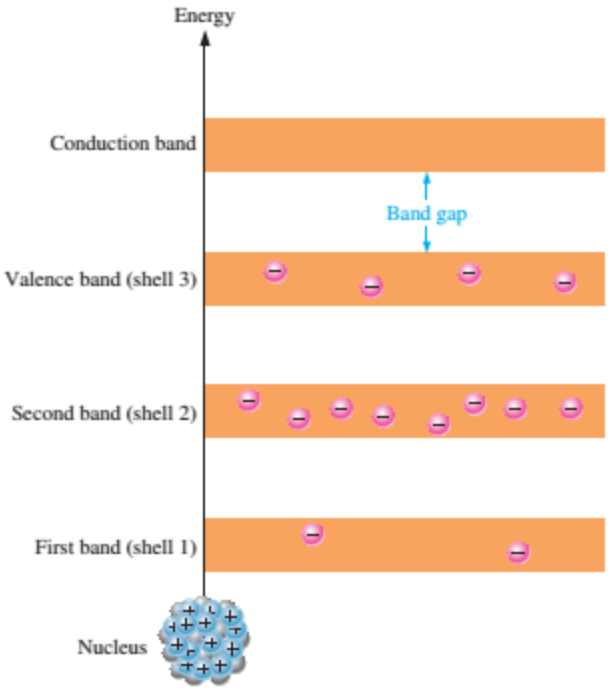
- Both Silicon and Germanium atoms have four valence electrons
- Valence electrons that orbit farther from the nucleus are less tightly bound to the atom than those closer to the nucleus.
- The Silicon atoms arrange themselves in fixed pattern called "Crystal''.



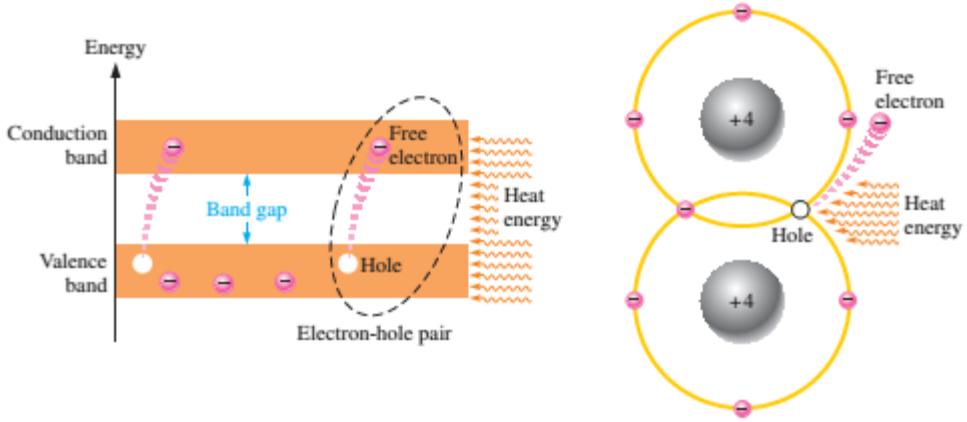
- The atoms are held together by covalent bonds (interaction of the valence electrons in each atom).

1-2 Conduction in Semiconductor Crystals

- Electrons of Si atom can exist only within specific energy bands.



- Each shell around the nucleus corresponds to a certain energy band.
- No electrons can exist in energy gaps.

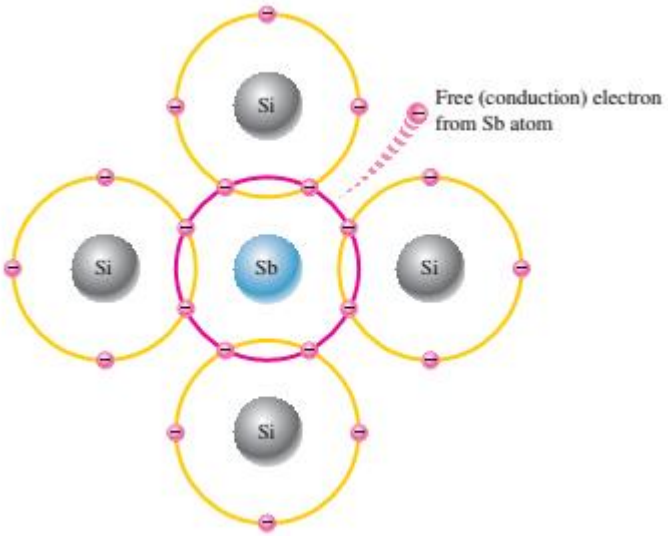


- A pure Silicon crystal at room temperature takes heat from surrounding air, causing some valence electrons to gain sufficient energy to jump the gap from the valence band into the conduction band, becoming free electrons.

1-3 n-type and p-type Semiconductors

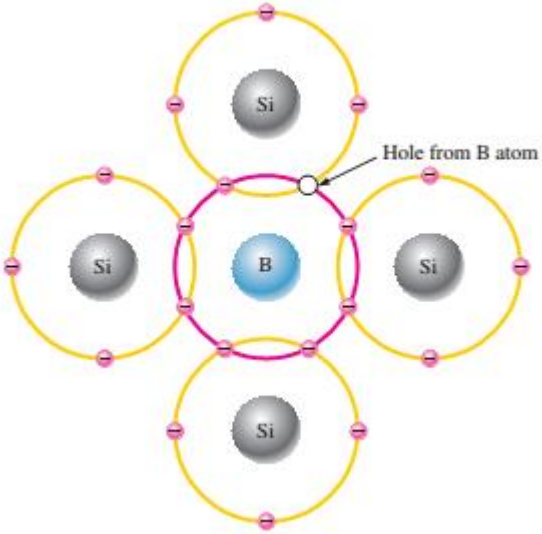
1-3.1 n-type Semiconductor

- To increase the number of conduction band electrons in pure Silicon, atoms with five valence electrons such as Phosphorus or Antimony are added.



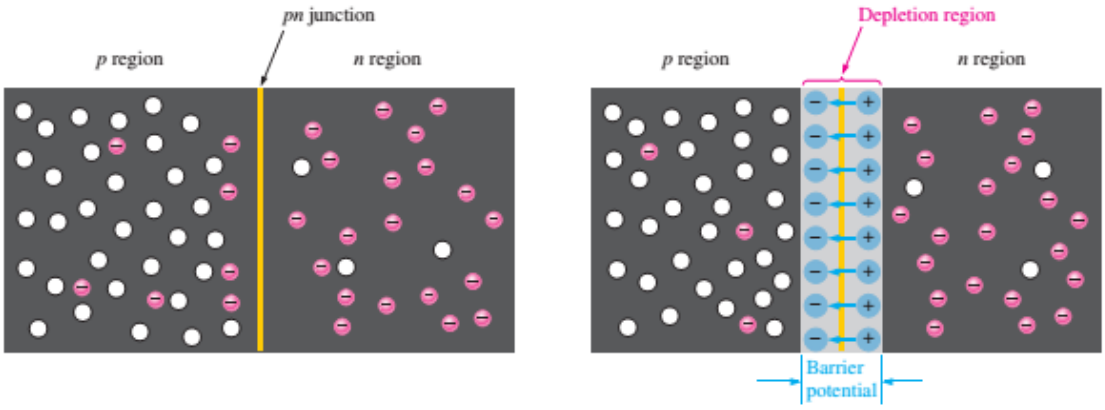
1-3.2 p-type Semiconductor

- To increase the number of holes in pure silicon, atoms with three valence electrons such as Aluminum or Boron are added.



1-4 pn Junctions

- A piece of Silicon is doped so that half is n-type and the other half is p-type, a pn junction is formed between the two regions.



1-4.1 The Depletion Layer

- For each electron that crosses the junction and recombines with a hole, n-type atoms are left with a net positive charge near the junction, making it a positive ion.
- When the electron recombines with a hole in the p-region, a p-type atom acquires net negative charge making it a negative ion.