15장 반도체의 기본

Introduction of semiconductor

15-1 게르마늄과 실리콘의 반도전성

- Characteristics fall between those of insulators and conductors.

- There are three pure semiconductor elements:
  - Carbon (C).
  - Germanium (Ge).
  - Silicon (Si).

15-1 게르마늄과 실리콘의 반도전성

- Germanium
  - Brittle, grayish element.
  - Discovered in 1886.
  - Recovered from the ashes of certain types of coal.
  - Reduced to solid form—pure germanium.

15-1 게르마늄과 실리콘의 반도전성

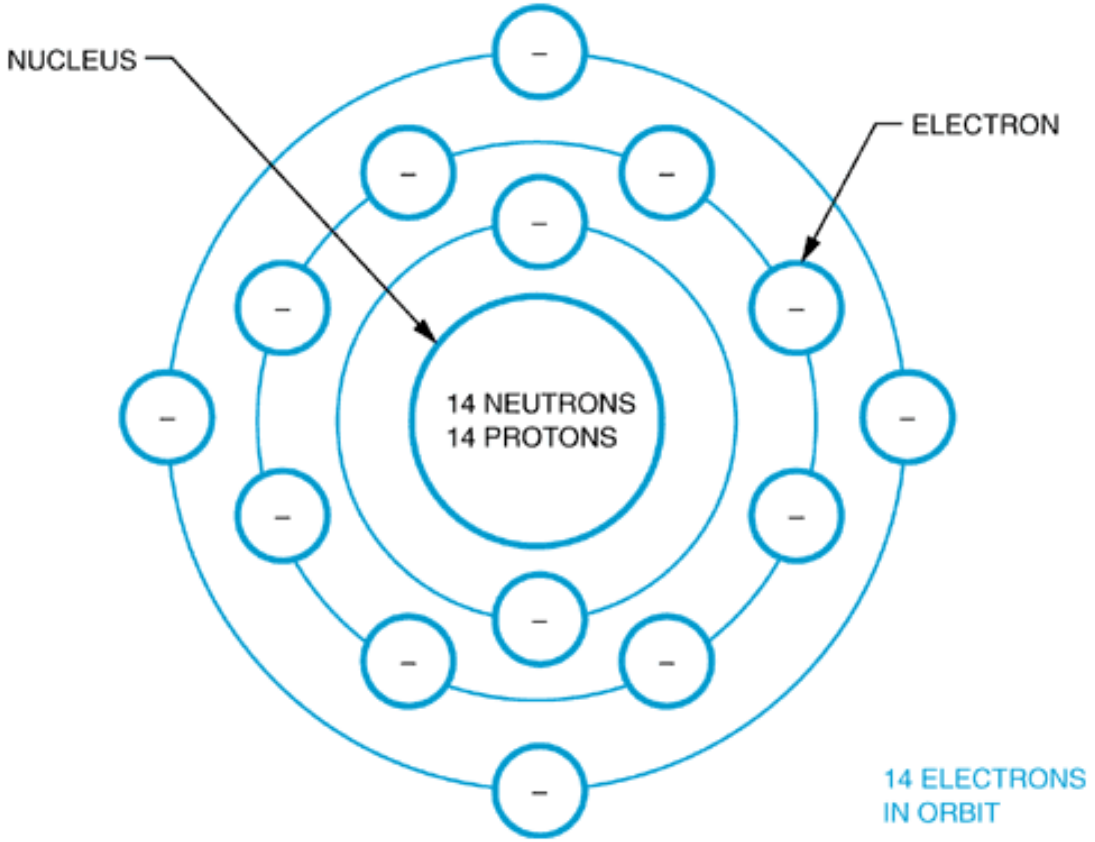
microsystems

► Silicon

- Discovered in 1823.
- Found in the earth's crust as silicon dioxide.
- White or sometimes colorless.
- Abundantly found in sand, quartz, agate, and flint.
- Chemically reduced to pure silicon in solid form.
- Most commonly used semiconductor material.

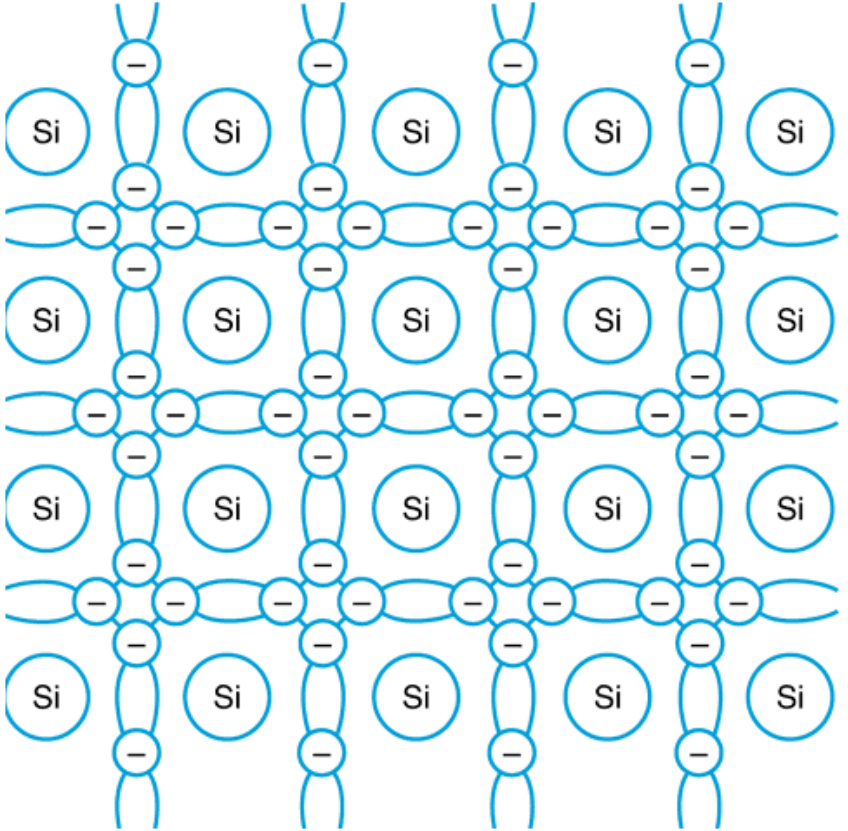
15-1 게르마늄과 실리콘의 반도전성

- Silicon



15-1 게르마늄과 실리콘의 반도전성

- Covalent Bonding: the process of sharing valence electrons, resulting in the formation of crystals.



15-1 게르마늄과 실리콘의 반도전성

- As the temperature increases, its resistance decreases.
  - For silicon, resistance is cut in half for every 6 degrees Celsius of rise in temperature.
  - For germanium, resistance is cut in half for every 10 degrees Celsius of rise in temperature.
  - Silicon has 1000 times more resistance than germanium at room temperature, thus making it more stable.
  - Germanium is used where heat-sensitive applications are necessary.
  - Today, silicon is used for most solid-state applications.

15-1 게르마늄과 실리콘의 반도전성

- Electrical activity is highly dependent on temperature.
- Germanium and silicon crystals function as insulators at low temperatures.
- As the temperature rises, they begin to acquire the characteristics of a conductor.

15-2 순수 게르마늄과 실리콘의 전도성

► Hole

- The absence of an electron.
- Represents the loss of a negative charge.
- Therefore, it has the characteristic of a positively charged particle.
- Each corresponding electron and hole are referred to as an *electron-hole pair*.

15-2 순수 게르마늄과 실리콘의 전도성

► Hole

- Holes constantly drift toward the negative terminal of the voltage source.
- Electrons flow toward the positive terminal.
- Current flow in a semiconductor consists of the movement of both electrons and holes.
- The amount of current flow is determined by the number of electron-hole pairs.
- The ability to support current flow increases with the temperature of the material.

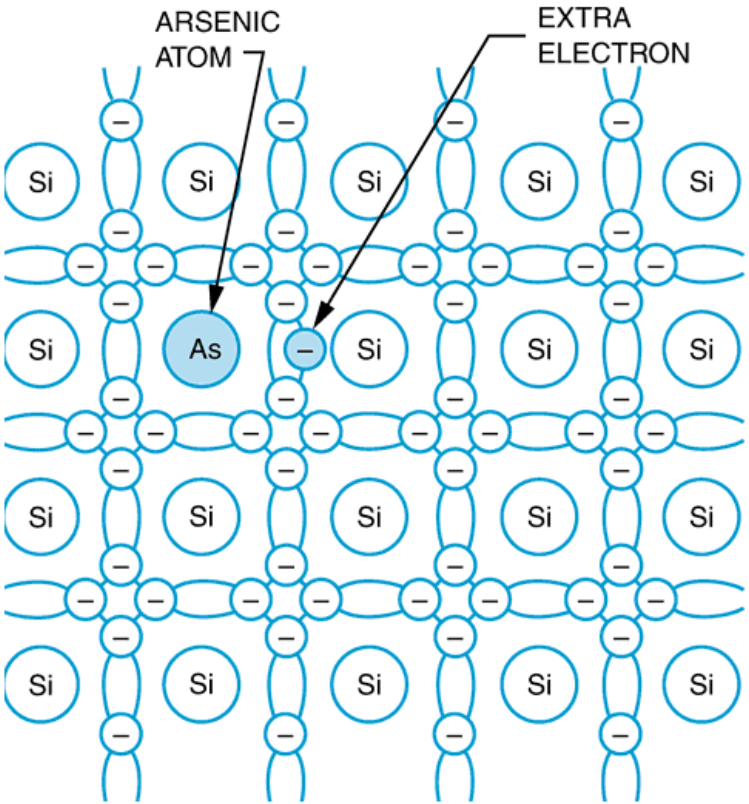
15-3 도핑된 게르마늄과 실리콘의 전도성

15-3 도핑된 게르마늄과 실리콘의 전도성

- Doping is the process of adding impurities to a semiconductor material.
  - § Pentavalent is made of atoms with five valence electrons.
    - Arsenic (As): 비소.
    - Antimony (Sb): 안티몬.
  - § Trivalent is made of atoms with three valence atoms.
    - Indium (In): 인듐.
    - Gallium (Ga): 갈륨.

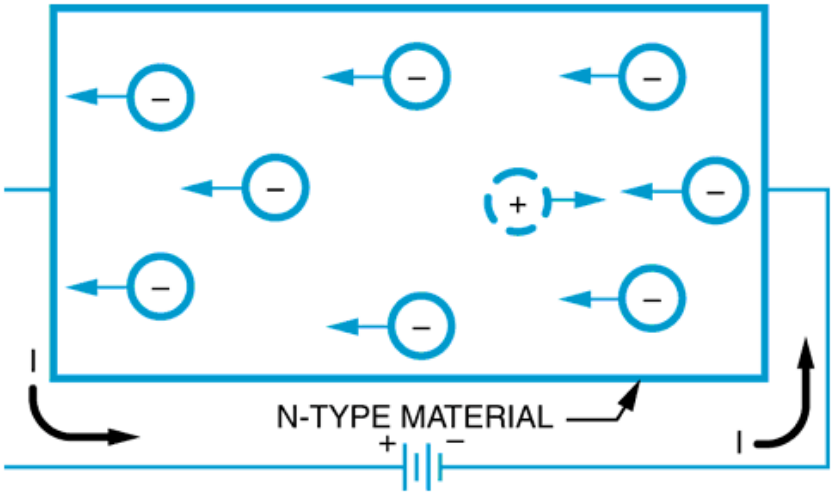
15-3 도핑된 게르마늄과 실리콘의 전도성

► N type material



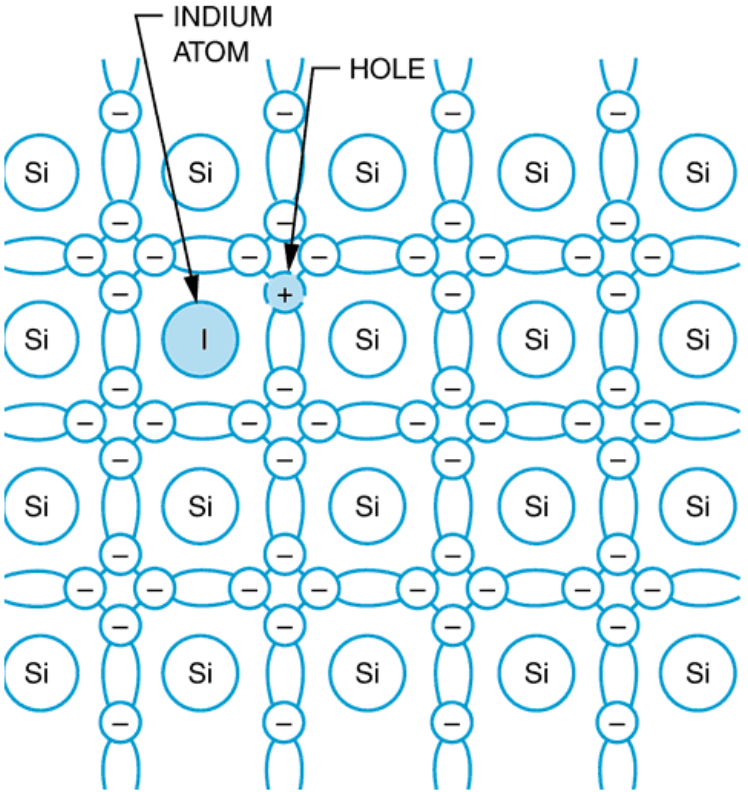
15-3 도핑된 게르마늄과 실리콘의 전도성

- N type material
  - Has more electrons than holes.
  - Negative charge is the majority carrier.
  - Free electrons flow toward the positive terminal.



15-3 도핑된 게르마늄과 실리콘의 전도성

► P type material



15-3 도핑된 게르마늄과 실리콘의 전도성

► P type material

– Has more holes than electrons.
– Positive charge is the majority carrier.
– The holes move toward the negative terminal.