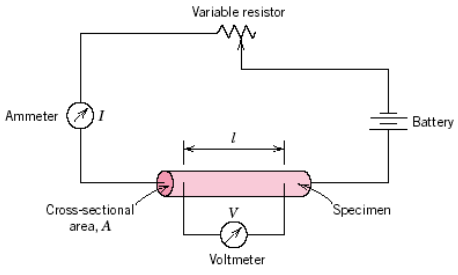
Chapter 18 Electrical properties

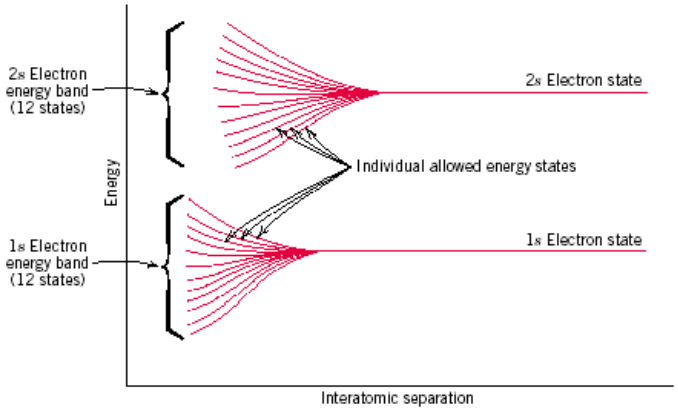
- Introduction
- Ohm's law
- Electrical conductivity
- Electronic and ionic conduction
- Energy band structures in solids
- Conduction in terms of band and atomic bonding atoms
- Electron mobility
- Electrical resistivity of metals
- Electrical characteristics of commercial alloys
- Intrinsic semiconductors
- Extrinsic semiconductors

Electrical conduction

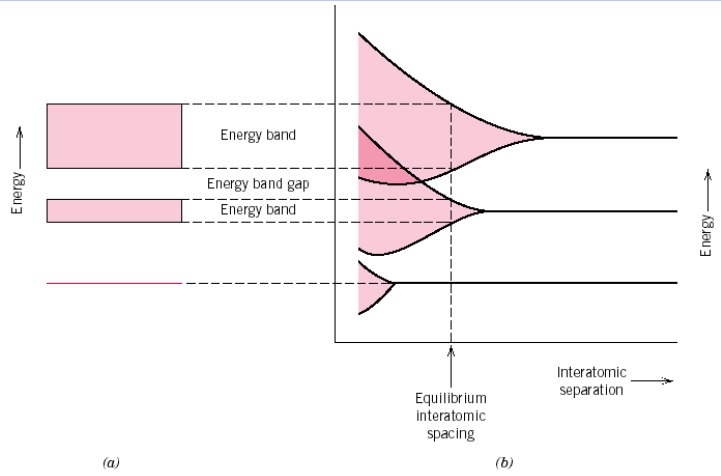
- Ohm's law V=IR
  - Resistivity $\rho = RA/l = VA/Il$
- Electrical conductivity
  - $\sigma = 1/\rho$
  - Another expression of Ohm's law $J = \sigma\xi$
  - Metals-- good conductors $10^{7}(\Omega\text{-m})^{-1}$
  - Insulators 10^{-10} and 10^{-20} $(\Omega\text{-m})^{-1}$
  - Semiconductors 10^{-6}-10^{4} $(\Omega\text{-m})^{-1}$
- Electronic and ionic conduction



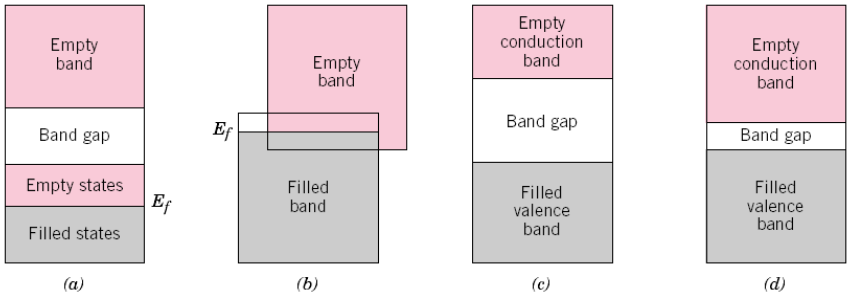
Energy band structures in solids



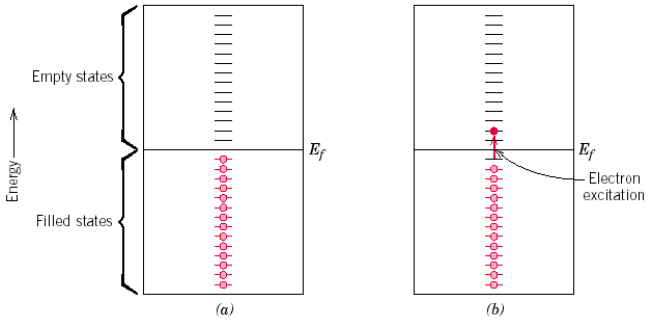
Energy band structures in solids (*continue*)



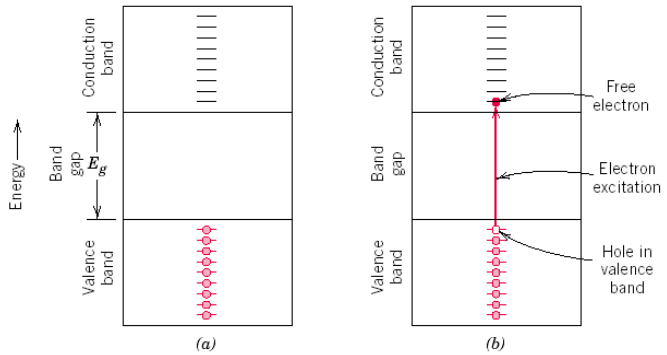
Various possible electron band structures



Conduction in terms of band and atomic bonding models

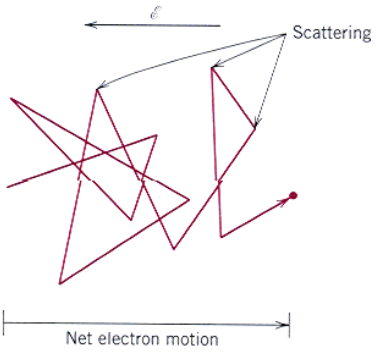


Conduction in terms of band and atomic bonding models



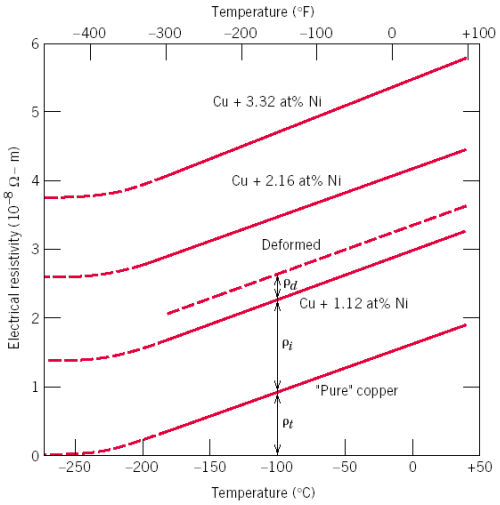
Electron mobility

- Drifting velocity: average electron velocity in the direction of the force imposed by the applied field
- The conductivity



Electrical resistivity of metals

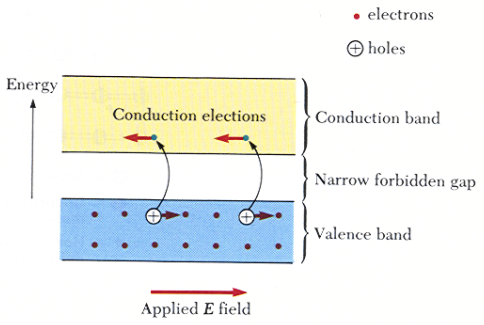
- Mathiessen's rule



Intrinsic semiconductor

- Intrinsic semiconductor:

- Intrinsic semiconductor band structure

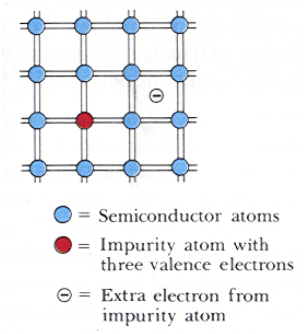


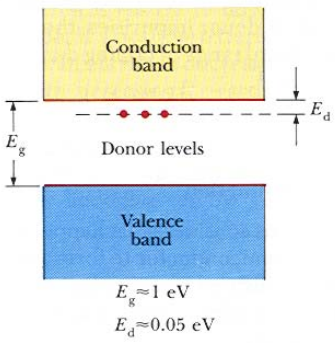
Intrinsic semiconductor

- Elemental semiconductor
- Compound semiconductor
- Electric conductivity

Extrinsic semiconductor

- The electrical behavior is determined by impurities.
- N-type semiconductor





Extrinsic semiconductors(*continue*)

- P-type semiconductor: trivalent substitutional impurities aluminum, boron, and gallium