Solids and Materials (Chapter 12, excluding Section 12.9)

Crystalline Solids

1. Crystal Lattice

A ***crystal lattice*** is a regular, repeating, 3-dimensional pattern in which the particles of a crystalline solid are arranged.

Depending on the type of substance, the lattice sites can be occupied by atoms, molecules, or ions.

unit cell -- simplest geometrical unit that defines the crystal lattice

Common types of crystal lattices:

simple cubic
- -- particle at 8 corners of a cube
- -- total of one particle per unit cell

face-centered cubic (e.g., NaCl)
- -- simple cubic plus particle at center of each face of the cube
- -- total of 4 particles per unit cell

body-centered cubic
- -- simple cubic plus particle at center of cube
- -- total of 2 particles per unit cell

2. X-Ray Diffraction

technique for determining crystal lattice and molecular structures
provides very accurate bond distances and angles

Bragg equation -- basic mathematical tool of x-ray diffraction
(Figure 12.1)

3. *Types of Crystals* (Figure 12.10)

Crystal Type	Lattice Sites	Forces	Properties
Ionic	anions and cations	electrostatic	hard, brittle, high mp / bp, conduct electricity when molten but not solid
Molecular	atoms or molecules	dipole-dipole, London forces, or H-bonding	soft, low mp / bp, non-conductors of electricity
Covalent (network)	atoms	covalent bonds	very hard, very high mp's, non-conductors
Metallic	positive ions	metallic bonds (cations in a "sea of electrons")	soft to hard, low to high mp, lustrous, good conductors
Non-bonding	atoms	London dispersion	very low mp's (e.g. solid Ar)

4. ***Amorphous Solids*** -- non-crystalline, glassy substances

Bonding in Solids -- Band Theory

An energy "***band***" is composed of a very large number of closely spaced energy levels that are formed by combining similar atomic orbitals of atoms throughout the substance

Metals and metalloids have a

"***conduction band***" (Figure 12.24) ⟶ set of highly delocalized, partially filled, MO's that extend over the entire solid lattice structure

"***band gap***" ⟶ energy difference between filled "***valence band***" and the ***conduction band***

Polymers and Plastics (Section 12.9) -- **Save until end of next semester!**