



Lecture1: Atomic Structure and Atomic Bonding

Introduction

Understanding the atomic structure and atomic bonding is fundamental to materials science and engineering. The physical, mechanical, electrical, and magnetic properties of engineering materials are directly related to the arrangement of atoms and the forces that bind them together. This lecture provides an overview of atomic structure and the main types of atomic bonding, forming a foundation for studying material behavior and applications.

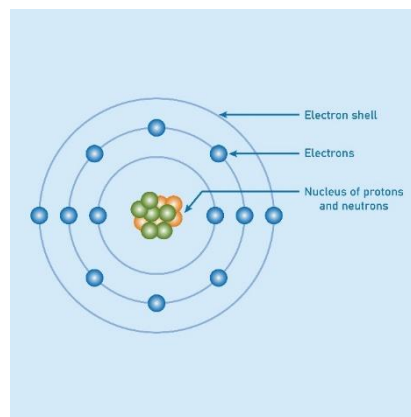
1. Atomic Structure

1.1 Basic Atomic Components

An atom is the smallest unit of matter that retains the properties of an element. It consists of three main subatomic particles:

- Protons: Positively charged particles located in the nucleus.
- Neutrons: Neutral particles located in the nucleus.
- Electrons: Negatively charged particles that orbit the nucleus in specific energy levels.

The number of protons determines the atomic number and identifies the element, while the combination of protons and neutrons determines the atomic mass.



1.2 Electron Energy Levels



Electrons occupy discrete energy levels or shells around the nucleus. These shells are divided into subshells (s, p, d, f), each with a specific energy and capacity.

- The valence electrons, located in the outermost shell, play a critical role in atomic bonding.
- The chemical reactivity and bonding behavior of an element depend mainly on its valence electron configuration.

1.3 Atomic Stability

Atoms tend to achieve a stable electron configuration, usually by filling their outer shell. This drive for stability is the main reason atoms form bonds with one another.

2. Atomic Bonding

Atomic bonding refers to the attractive forces that hold atoms together in molecules or solids. These bonds result from interactions between electrons and nuclei.

2.1 Primary Bonds

2.1.1 Ionic Bonding

Ionic bonding occurs when one atom transfers one or more electrons to another atom.

- Typically occurs between metals and non-metals.
- Results in the formation of positive and negative ions.
- The bond is based on electrostatic attraction.
- Common in ceramic materials.

Characteristics:

- High melting point
- Brittle behavior
- Poor electrical conductivity (except in molten or dissolved states)