

# Chapter 2

## Atomic Bonding in Solids

### Overview

Quantum theory explains how electrons in atoms only exist in discrete energy states. Combined with the Pauli Principle, this implies that the lowest energy configuration of an atom is achieved by electrons filling energy states one-by-one, from the lowest state on up. The properties of the outermost electron states suggest a natural explanation of the systematics of the periodic table. Electrons also exist in discrete states in molecules. These molecular electron states, in turn, determine the nature of the bonding within and between molecules. Bonding between atoms in solids can be understood by an extension of the principles of atomic and molecular electron states, together with the notion of the extent of electron sharing among many atoms. Thus a natural path emerges to a description of bonding in the different classes of solids. A universal atom-atom bonding curve provides a unified description of such phenomena as the bond strength of solids, bond stiffness, thermal expansion, and melting point.

**After studying this chapter, you will be able to :**

1. Describe energy states of electrons in atoms, the shapes of atom electron orbitals and their associated charge distributions;
2. Make the connection between the electron configuration of atoms and their position in the periodic table ;
3. Show how interactions between electrons and nuclei give rise to bonding within molecules (covalent, ionic bonding) and between molecules (dipole-dipole, van der Waals bonding) ;
4. Outline how concepts of chemical bonding and electron sharing are associated with the characteristics of different types of solids;
5. Explain how a universal bonding curve can describe inter-atomic bonding in solids, and hence such features as bond strength, bond stiffness, and thermal expansion.