Class: `1st Stage
Subject: Engineering Materials

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Inter atomic Bonding

There are four important mechanisms by which atoms are bonded in engineered materials. These are:

1. Metallic bond.
2. Covalent bond.
3. Ionic bond.
4. Van der Waals bond.

1.The Metallic Bond: It is the atomic bonding mechanism in pure metals and metal alloys. The metallic bond forms when atoms give up their valence electrons, which then form an electron sea. The positively charged atom cores are bonded by mutual attraction to the negatively charged electrons.

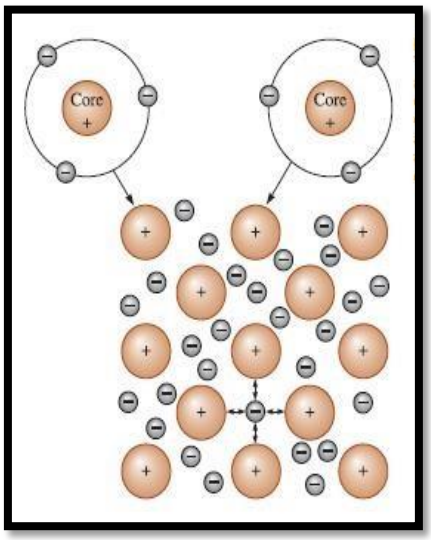

Figure 1. Diagrammatic Representation of the "Metallic Bond".

Because their valence electrons are not fixed in any one position, Because of the general distribution of electrons and their freedom to move within the metal, metallic bonding provides typical properties of materials characterized such as good electrical conductivity, good conduction of heat and good ductility.

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2.The Covalent Bond: In the covalent bond, electrons are shared (as opposed to transferred) between atoms in their outermost shells to achieve a stable set of eight. For example, a silicon atom, which has a valence of four, gets eight electrons in its outer energy shell by sharing its electrons with four surrounding silicon atoms (Figure 2). Each instance (case) of sharing represents one covalent bond; thus, each silicon atom is bonded to four neighboring atoms by four covalent bonds. Solids with covalent bonding generally possess high hardness and low electrical conductivity.

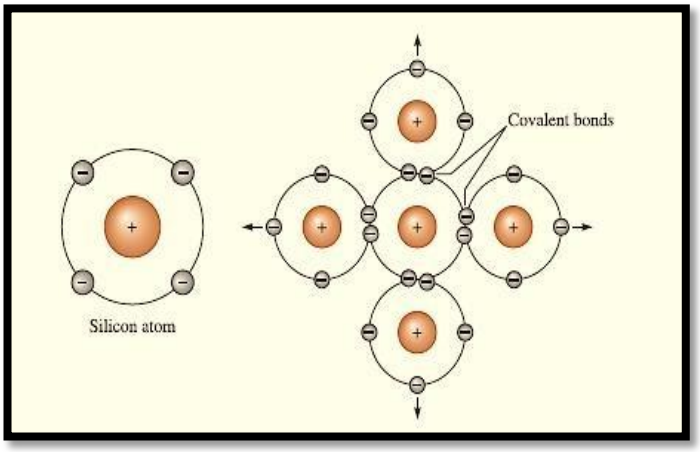

Figure 2. Covalent bonding requires that electrons be shared between atoms in such a way that each atom has its outer **sp** orbital filled. In silicon, with a valence of four, four covalent bonds must be formed for every atom.

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3.The Ionic Bond: In the ionic bond, when more than one type of atoms are present in a material, one atom may donate its valence electrons to a different atom, filling the outer energy shell of the second atom. The atom that contributes the electrons is left with a net positive charge and is called a cation, while the atom that accepts the electrons acquires a net negative charge and is called an anion. The oppositely charged ions are then attracted to one another and produce the ionic bond. This bond is naturally provides a very strong bond between atoms and as a properties of solid materials with the ionic bonding include low electrical conductivity and poor ductility.

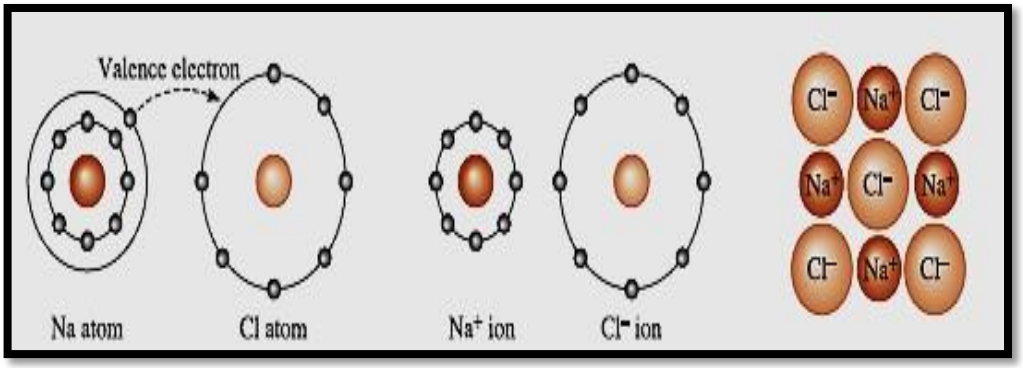

Figure 3. An ionic bond is created between two unlike atoms with different electronegativities. When sodium donates its valence electron to chlorine, each atom becomes an ion, and the ionic bond is formed.

Solids that exhibit considerable ionic bonding are also often mechanically strong because of the strength of the bonds. Electrical conductivity of ionically bonded solids is very limited. A large fraction of the electrical current is transferred via the movement of ions. Owing to their size, ions typically do not move as easily as electrons.

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4.Van der Waals Bonding: They are very small forces of attraction acting between atoms in cases where the formation of ionic or covalent bonds is not possible. Basically similar forces also act between atoms which are already bounded in neighboring molecules , giving rise to weak Van der Waal's forces between long-chain molecules in polymers.

Mixed Bonding: In most materials, bonding between atoms is a mixture of two or more types. **Iron**, for example, is bonded by a combination of metallic and covalent bonding that prevents atoms from packing as efficiently as we might expect.