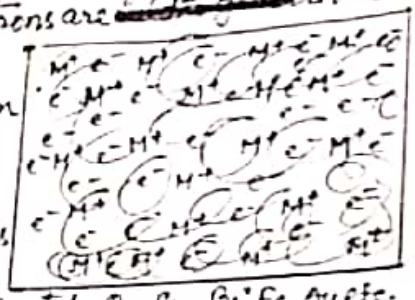
# B.Sc-II (Hons), Paper-III B (Inorg. chem)

## Group A, Unit-2, Chemical bonding [By Dr. Girendra Kumar]

### (b) Metallic bond?

In metallic crystals, metal cations are surrounded by a sea of mobile electrons. The metal cations are in their positions and mobile electrons are ~~[illegible]~~ in the interstices between them. The metal cations and mobile electrons are held together by electrostatic force of attraction known as metallic bond.



Thus, metallic bond can be defined as "the force of attraction between the metal cations and the mobile electrons and this force holds the metal atoms finally together in the metallic crystal/lattice". Most of metals, e.g. Ag, W, alkali metals, Os, Cu, Be, Fe, Au etc. and alloys have metallic bond.

Factors affecting metallic bond: (i) Ionisation energy of the metals should be low so that the valence electrons of the metal are loosely held by the nucleus and thus become mobile (ii) The metal should have low electronegativity so that they do not accept electrons. (iii) The number of vacant orbitals in a metal should be more than the number of valence electrons in it so that the mobile electrons easily move into the vacant orbitals.

Features of metallic bond: (i) It is weaker bond than ionic & covalent bonds. (ii) It is non directional (iii) It is electrostatic nature, i.e; electrostatic force of attraction acting between kernels (metal cations) and mobile electrons.

⟹ Theories of Metallic bond: To explain nature of metallic bond, following theories ill

1. Free electron theory: This theory was proposed by Lorentz, and also called electron cloud theory. According to this theory, since the ionisation energies of metals are very low, they readily lose their valence electrons and form metal cations (Kernels). The electrons given up by the metal atoms are not stationary but can move freely from one place to the other through the vacant orbitals. Thus, these electrons are mobile or delocalised (sea). The force of attraction between Kernels & mobile electrons holds the metal atoms together in the metallic crystal (fig-1).

2. Valence bond theory: This theory was given by Pauling, and also called resonance theory. According to this theory, metallic bond is covalent in origin and the structure of a metal involves resonance of covalent bonds between each atom & its nearest neighbour. For example, in Lithium metal, it has been observed that a Li-atom is surrounded by 8 neighbouring Li-atoms. Since the single electron in 2s-orbital cannot form covalent bonds with 8 neighbouring Li-atoms, it is assumed that resonance takes place throughout the solid. Different resonance (Contributing) forms can be written as:

$$Li_a-Li_b \longleftrightarrow \begin{matrix} Li_a & Li_b \\ | & | \\ Li_c & Li_d \end{matrix} \longleftrightarrow \begin{matrix} Li_a & Li_b \\ | & | \\ Li_d & Li_c \end{matrix} \longleftrightarrow \begin{matrix} Li_a^+ & Li_b^- \\ | & | \\ Li_d^- & Li_c \end{matrix} \longleftrightarrow Li_a-\bar{L}i_b^+ \longleftrightarrow \begin{matrix} Li_a^- & Li_b^+ \\ | & | \\ Li_d & Li_c \end{matrix}$$

(I) (II) (III) (IV) (V) (VI)

Here $Li$: $1s^2 2s^1 2p_x^0 2p_y^0 2p_z^0$ ; $Li^+$: $1s^2 2s^0 2p_x^0 2p_y^0 2p_z^0$, $Li^-$: $1s^2 2s^1 2p_x^1 2p_y^0 2p_z^0$.

The contributing structures (III to VI) contain a negatively charged Li-atom which is bonded to other two Li-atoms by ($\sigma_{sp}$-s) covalent bonds. These covalent bonds are called resonating covalent bonds.

Thus, in terms of VBT of metallic bond, formation of resonating covalent bonds is that there should be orbitals, energetically not very different from the outermost occupied orbitals in the configuration of Li-atom. The two vacant orbitals ($2p_y$ & $2p_z$) on $Li^-$ can accept the conductivity electrons & called metallic orbital