SOLID STATE PHYSICS - II

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Crystal Bonding

Types of Bonding:

1. Ionic Bonding:-	NaCl, LiF
2. Covalent Bonding:-	Diamond, Si, C
3. Van der Waal Bonding:-	Solid Argon
4. Hydrogen Bonding:-	Ice
5. Metallic Bonding:-	Cu, Ag, Fe

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1. Ionic Bonding:

An ionic bonding is the Attractive Force existing betwe
and a negative ion when they are brought into close pr
surrounding.
They are formed when atoms of different element
their electrons in order to achieve stabilized outermost
configuration.

Na   **Cl**
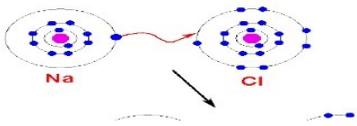
PROPERT

❖ Ionic solids are rigid, unidirectional and crystalli
❖ They have high melting and boiling points.
❖ Ionic solids are good insulators of electricity in t
state and good conductor of electricity in their m

Potential Energy of Ionic Crystal:

The force of attraction between Na^+ and Cl^- ions in Sodium Chloride is

$$F = Z_1 Z_2 e^2 / 4\pi\varepsilon_0 r^2$$

Thus the attractive potential energy is

$$V_a = - F. r = - Z_1 Z_2 e^2 / 4\pi\varepsilon_0 r$$
$$= - \alpha e^2 / 4\pi\varepsilon_0 r$$

α is Madelung Constant.

The repulsive potential energy is $V_r \propto 1/r^n$

$$V_r = B/r^n$$

Thus the resultant potential energy $V = V_a + V_r$

$$= - \alpha e^2 / 4\pi\varepsilon_0 r + B/r^n$$

At the equilibrium separation r_0, V has minimum value.

$$(dV/dr)_{r=r0} = 0 \quad \text{of} \quad V = - \alpha e^2 / 4\pi\varepsilon_0 r + B/r^n$$

So $\quad B = \alpha r_0^{n-1} e^2 / 4\pi\varepsilon_0 n$

$$V = - \alpha e^2 / 4\pi\varepsilon_0 r_0 (1 - 1/n)$$

Total binding energy of a crystal having N positive and N negative ions is given by

$$V = N\alpha e^2 / 4\pi\varepsilon_0 r_0 (1 - 1/n)$$

If the energy needed to transfer an electron from Na to Cl atom to become Na^+ and Cl^- ion is V_i, then total potential energy known as **Cohesive energy** is given by

$$V_c = V_a + V_r + V_i$$

COVALENT BONDING

A covalent bond is formed, when two or mo
of an atom, in its outermost energy level, are sha
atoms. e.g.–Chlorine molecule.
In this bonding a stable arrangement is achi
sharing of electrons rather than transfer of elect
Sometimes a covalent bond is also formed v
atoms of different non–metals share one or mor
electrons in their outermost energy level.
e.g.– Water molecule

Bonding between two atoms of same element

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Propertie

1) **Covalent compounds generally hav lower melting and boiling points than compounds.**

3) **Covalent compounds tend to l flammable than ionic compound:**

4) **Covalent compounds don't co electricity in water.**

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Van der Waals Bondings

van der Waals interactions are bonds between fluctuating, induced dipoles within the electron clouds of interacting molecules. These bonds can occur between nonpolar or polar molecules. van der Waals bonds are extremely dependent on the distance of separation between molecules, and are significant only when the electron clouds of the molecules are just touching. van der Waals interactions are demonstrated for two O_2 molecules in Fig. 2.10. The covalent and van der Waals radii are shown.
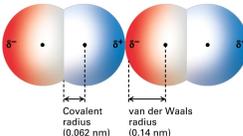
Covalent radius (0.062 nm)

van der Waals radius (0.14 nm)

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❑ Its main characteristics are:-

- They are weaker than normal covalent ionic bon
- Van der Waals forces are additive and cannot be
- They have no directional characteristic.
- They are all short - range forces and hence only interactions between nearest need to be conside instead of all the particles. The greater is the attr the molecules are closer due to Van der Waals fo
- Van der Waals forces are independent of temper except dipole - dipole interactions.

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THANK YOU

ALL THE BEST