

DEFINITION

Ionic bonding occurs between a metal and a non metal ion with the electrostatic attraction between the ions. The electron will leave the low electronegative metal and move to the high electronegative non-metal.

Characteristics

- electrons placed inside the atoms
- strong electrostatic bonds
- no directional preference
- high melting and boiling points
- soluble in polar solvents (water, alcohols, ...)

WHY?

BECAUSE OF LATTICE ENERGY

it is the enthalpy of formation of the ionic compound from gaseous ions, the measurement of the bonds' strength

Type of ionic interactions

- electrostatic (main interaction)
- repulsive (between the electrons)
- repulsive (between the nuclei)

Formulae

For a mole of solid:

$$E_0 = -NA \frac{q_1 q_2 e^2}{4\pi\epsilon_0 d} \cdot \frac{1}{2} \ln 2$$

MADELUNG CONSTANT

- Depends on the relative position of the ions in the solid
- Is characteristic for each "structure"

Formulae

$$U_{\text{lattice}} = \frac{E_{\text{attractive}}}{E_0} + \frac{E_{\text{repulsive}}}{E_r}$$

Born-Landé equation

$$U = -\frac{AN_A}{4\pi\epsilon_0} \frac{Z_1 Z_2 e^2}{d} \left(1 - \frac{1}{n}\right)$$

Born-Haber Cycle

Lattice energy cannot be easily obtained experimentally Thus, we apply the Hess Law to realize indirect calculations

standard enthalpy of formation ΔH_f

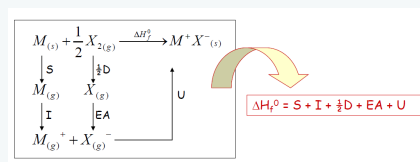
enthalpy of sublimation $\Delta H_s = S$

enthalpy of dissociation $\Delta H_d = D$

ionization energy (take an electron) $\Delta H_i = I$

electron affinity (add an electron) $\Delta H_{EA} = EA$

Born-Haber Cycle



Ionic Liquids (IL)

Salts in liquid state at room temperature made of ions Possible when the ionic charges aren't too high and the distance is large enough

Useful properties

- non volatile -remain in liquid state up to 400°C
- non flammable -good solvents for reactions
- reduced volume -easy reuse

Ionic Conductors (Superconductors)

They are solid state ion conductors used primarily in solid oxide fuel cells. They conduct electricity due to the movement of the ions through the voids.

An example would be yttria-stabilized zirconia (YSZ)

Ionic Solids

Physical behaviour

-HARD(-NESS) related with the attractive cohesion force in the ionic structure. This property is related with the absolute value of the lattice energy (directly to the charge of ions, inversely to their size)

-RIGID strong attractive forces hold ions in specific positions

-BRITTLE when enough force is applied, ions of similar charge are brought next to each other, and repulsions between them crack the sample

ELECTRIC CONDUCTIVITY

-solid state insulators (the valence electrons aren't mobile and the ions are in fixed positions))

-when molten electricity conductor (ions are mobile)

Ionic Solids (cont)

-when dissolved in polar solvents electricity conductor (ions are mobile)

SOLUBILITY

$\Delta H_{\text{solution}} = -U + \Delta H_{\text{solvation}}$ the higher the lattice energy of a salt, the less soluble it is

MELTING AND BOILING POINTS

-high melting point freeing ions from their positions require large amount of energy

-much higher boiling points (the higher U is, the higher its boiling/melting point is)