Ionic Solids

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Characteristic of ionic solid

- Conductivity
  - Solid
    - Ion strongly bond at crystal site
    - Ion can not migrate
    - Not conduct current
  - Melt
    - Ion can migrate
    - Conductor

Characteristic of ionic solid

- Melting point
  - Ionic bond occur to all direction
  - Strong ionic bonding
  - Has high m.p.

Characteristic of ionic solid

- Ductile
  - When force hit the solid
  - Bond length shorter
  - Attraction force becomes repulsion force
  - Readily broken
- Dissolves in polar solvent

Model & Size of Ionic Compound

Atomic number >>>

Nuclei charge >>>

Atomic radius <<<

Model & Size of Ionic Compound

- Cation
  - Released electron
  - Effective nuclei charge >>>
  - Attraction force >>>
  - Cation size <<<
  - Radius of Na = 186 pm, Na^+ = 116 pm
  - Volume Na^+ = 0.25 V Na

Model & Size of Ionic Compound

- Anion
  - Accept electron
  - Effective nuclei charge <<<
  - Attraction force <<<
  - Anion size >>>
  - Radius of O = 74 pm, O^{2-} = 124 pm
  - Volume O^{2-} = 5 V O

Trends of Ionic Radius

- Cation
  - Radius of: $_{11}Na^{+}$, $_{12}Mg^{2+}$, $_{13}Al^{3+}$ = 116, 86, 28 pm
  - Left to right: (+) charge>>>, effective nuclei charge >>>, ionic radius <<<

Trends of Ionic Radius

- Anion
  - Radius of: $_7N^{3-}$, $_8O^{2-}$, $_9F^{-}$ = 132, 124, 117 pm
  - Left to right: (-) charge <<<, effective nuclei charge >>>, ionic radius <<<
  - Radius of: F^-, Cl^-, Br^-, I^- = 117, 167, 182, 206 pm
  - Top to down (in a group): atomic number >>>, number of shell >>>, ionic size>>>

Trends of Melting Point

- Ionic bond
  - (+) charge are surrounded by (-) charge in crystal site
  - Attraction force between (+) and (-) charge

Trends of Melting Point

- Melting
  - Breaking of the attraction force
  - Ion can migrate freely in liquid phase
  - Ionic size <<<, bond strenght >>>, melting point >>>
    - M.p. Of KF, KCl, KBr, KI = 857, 772, 735, 685 ^{o}C

Polarization & Covalency

- Polarization: distort from the ideal form of anion (sphere)
- Polarization property >>>, degree of covalence >>>, covalent property >>>, covalent compound.
- ρ (charge density)

Polarization & Covalency

$$\rho = \frac{+1 \times 1{,}6 \times 10^{-19}\ C}{4/3\ (3{,}14) \times (1{,}16 \times 10^{-7}\ )^{3} mm} = 24\ C\ mm^{-3}$$

n = muatan ion

p = muatan proton = 1,6 x 10-19C

Polarization & Covalence

eg : radius of natrium = 116 pm

$= 1{,}16 \times 10^{-7}$ mm

so:

$$\rho = \frac{+1 \times 1{,}6 \times 10^{-19}\ \mathrm{C}}{4/3\ (3{,}14) \times (1{,}16 \times 10^{-7})^3\ \mathrm{mm}} = 24\ \mathrm{C\ mm^{-3}}$$

ρ >>>, polarization capacity >>>

Kasimir Fajans`s Rules

1. Cation size<< → (+) charge >> → polarize capacity >> → covalent compound
   - Radius of Al << Na

     ρ Na = 24 C mm^{-3}

     ρ Al = 364 C mm^{-3}
   - Polarization capacity of Al >> Na,
   - Al → covalent compound (m.p. <<)
   - Na → ionic compound (m.p. >>)

Kasimir Fajans`s Rules

2. Anion size >> → (-) charge >> → readily polarized → covalent compound
   - AlF_3 dan AlI_3
   - r F^- = 117 pm
   - r I^- = 206 pm
   - Polarized capacity of I^- >> F^-
   - AlF_3 → ionic compound
   - AlI_3 → covalent compound

Kasimir Fajans`s Rules

3. If the electronic configuration of the cation ≠ noble gas → polarize capacity >> → covalen compound
   - $_{11}Na$ = [10Ne] $3s^1$ → Na^+ = [10Ne]
   - $_{47}Ag$ = [36Kr] $4d^{10}$ $5s^1$ → Ag^+ = [36Kr] $4d^{10}$
     - e- configuration ≠ noble gas
     - polarize capacity of Ag^+ >> Na^+
   - AgF → covalen compound, mp = 435^oC
   - NaF → ionic compound, mp = ± 735^0C

AgF, AgCl, AgBr, AgI

- AgF
  - AgF → dissolves in water
  - Radius of F^- is the smallest compared to other halide ions.
  - F^- the most difficult to be polarized
  - Form ionic compound
  - Soluble in water
- AgCl, AgBr, AgI
  - Insoluble in water

Na_2O dan Cu_2O

- Na^+ = [10Ne] → ionic compound
- Cu^+ = [18Ar] $3d^{10}$ → covalent compound
  - e^- configuration ≠ e^- configuration of noble gas
  - Polarized capacity>>
  - Form covalent compound

Na_2O dan Cu_2O

- Electronegativity of

  Na = 0.9, Cu = 1.9, O = 3.5

  - Δ electronegativity in Na_2O = 2.6 → ionic
  - Δ electronegativity in Cu_2O = 1.6 → covalent

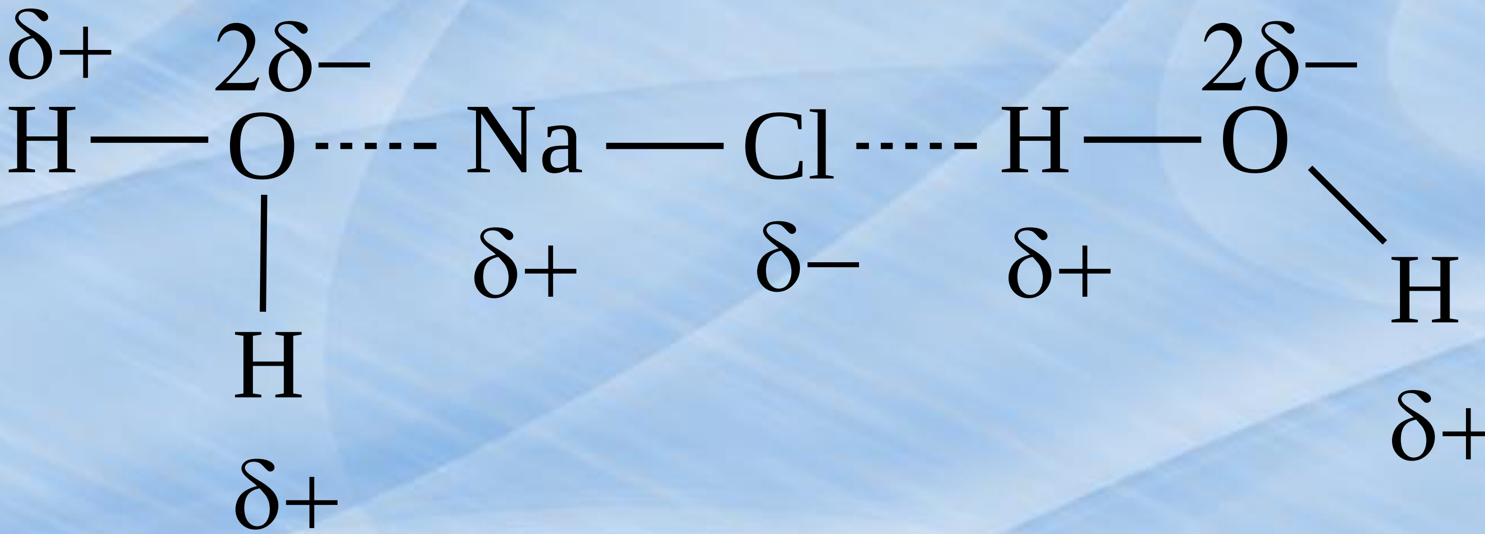
Δ electronegativy >> → ionic compound

Hydration of Ion

- Why ionic compound is water soluble?
  - There is ion-dipol interaction between ion and water molecule

Hydration of Ion

- Dissolution procces of NaCl in water



- If the dipol interaction >> total interaction of ions and water molecule → soluble