Beryllium, Magnesium, Calcium, Strontium, Barium & Radium

Uses of the Alkaline Earth Metals

Metals - Much more dense - 2e in metallic bonding results in higher mp, bp, \( \Delta H_{\text{vap}} \), \( \Delta H_{\text{fus}} \), \( \Delta H_{\text{subl}} \) harder than alkali metals but still soft.

Be - High strength, non-sparking alloys – uses limited by its toxicity. X-ray windows, neutron moderator for nuclear reactors. Relatively unreactive to \( \text{H}_2\text{O}, \text{O}_2 \).

Mg - Lighter than aluminum, construction, airframes, missiles, light weight castings. Bulk metal relatively unreactive due to tough oxide layer.

Ca - Limited alloy use - oxide/nitride skin partly successful in resisting corrosion, generally too chemically reactive. Alloy with lead in low maintenance storage batteries.

Sr and Ba - too chemically reactive. Ra – Radiation Source.

Unique Behavior of Beryllium (Magnesium)

- \( \text{Be(OH)}_2 \) is amphoteric – \( \text{Be(OH)}_4^{2-} \)
- \( \text{BeX}_2 \) – X = F, Cl, Br – Polymeric, linear with dative 2c-2e halogen bridge bonds.
- \( \text{BeH}_2 \) & \( \text{MgH}_2 \) – Polymeric with 3c-2e bonds. Ca, Sr, Ba hydrides are typical “saline” type.
- \( \text{Be(CH}_3\text{)}_2 \) & \( \text{Mg(CH}_3\text{)}_2 \) – Polymeric with 3c-2e bonds. Ca, Sr, Ba alkyls very ionic, less stable.
- Addition of MX\(_2\) will result invariably in X-bridging; also H bridges in preference to CH\(_3\).
Clusters – Basic Beryllium Acetate

Soluble in organic solvents, insoluble in water!

Volatile & Liquids

Any feature which prevents the formation of a “salt” lattice will cause “ion pairs” to behave like molecules.

Unusual Coordination Geometries

Coordination Number 2

Coordination Number 4 and Square Planar
Cyclopentadienyl Complexes

Be
H
ηηηη
1e
2e
5e

 obeys the octet rule

Mg
ηηηη
5e
ηηηη
5e

polymeric ring bridged
ηηηη
5e

12e
16e

Grignard Reagents

2 R-Mg+ + 2X-

associate
ionize
dissociate

2 R-Mg-X

associate
ionize
dissociate
associate