

5.2: Group 2 Metals

Group 2 metals from beryllium Be, to radium, Ra, are also called **alkaline earth metals** (Table 5.2.2). Beryllium is a component of beryl or emerald. Emerald is a mineral that contains about 2% of chromium, Cr, in beryl, $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$. Beryllium metal is silver white and is used in special alloys and for the window of X-ray tubes, or a moderator of nuclear reactors, etc. Compounds of Be^{2+} resemble the compounds of Mg^{2+} or Al^{3+} . Since beryllium is a deadly poison, it should be handled with due care.

Table 5.2.2 Properties of group 2 metals

	mp (°C)	bp (°C)	d(20 °C) (g cm ⁻³)	E ⁰ (V) M ²⁺ +2e ⁻	I first	(kJ mol ⁻¹) second
Be	1287	2471	1.85	-1.85	899	1757
Mg	650	1090	1.74	-2.37	737	1450
Ca	842	1484	1.55	-2.87	590	1145
Sr	777	1382	2.63	-2.90	549	1064
Ba	727	1897	3.62	-2.91	503	965
Ra	700		5.5	-2.82	509	975

Magnesium, Mg, is mainly produced as carbonates, sulfates, and silicates, and its abundance is between those of sodium and calcium, Ca. It is produced by molten salt electrolysis of magnesium chloride, MgCl_2 , or the reaction of dolomite, $\text{CaMg}(\text{CO}_3)_2$, with ferrosilicon alloy FeSi. Magnesium metal is silver white and the surface is oxidized in air. At high temperatures, magnesium reacts with nitrogen gas to become nitride, Mg_3N_2 . The metal burns very brightly and is still used for flash lights. The alloy with aluminum is light and strong and used as a structural material in cars and airplanes.

Mg^{2+} is the central metal ion in the porphyrin ring of chlorophyll, and plays an important role in photosynthesis. The Grignard reagent, RMgX , which F. A. V. Grignard of France synthesized in 1900, is a typical organometallic compound of a main-group metal and is widely used for Grignard reactions. This is an important reagent rewarded by a Nobel prize (1912), and is very useful not only for organic reactions but also for the conversion of metal halides into organometallic compounds.

Calcium is contained in silicates, carbonates, sulfates, phosphates, fluorite, etc. Calcium is a silver white and soft metal that is manufactured by molten salt electrolysis of calcium chloride CaCl_2 .

Quick lime, CaO , is produced by the calcination of limestone, CaCO_3 , at 950-1100 °C. Production of quick lime ranks second to sulfuric acid in inorganic chemical industries. Calcium hydroxide, $\text{Ca}(\text{OH})_2$, is called also slaked lime. Calcium carbonate is the principal component of limestone and limestone is very important for the production of cement. Gypsum is a dihydrate of calcium sulfate $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ and is obtained in large quantities as a by-product of stack gas desulfurization, and in addition to conventional uses is also used as a building material, etc.

Although calcium is not important in either the chemistry of aqueous solution systems or in organometallic chemistry in organic solvents, the element plays very important roles in living organisms. Not only is calcium the structure material of bones and teeth, calcium ions also have a wide range of functions in biological systems, such as protein stabilization, transfer of hormone action, muscular contraction, nerve communication, and blood coagulation.

Strontium, Sr, is a silver white soft metal. The surface is oxidized by air at room temperature, and it becomes a mixture of oxide, SrO , and nitride, Sr_3N_2 , at high temperatures. In spite of the relatively high content strontium in the Earth's crust, the element has not been studied widely and its application is limited. There are four natural isotopes and ^{88}Sr (82.58%) is the most abundant. Since the artificial isotope ^{90}Sr is obtained cheaply by nuclear reaction, it is used as a source of β particles, and as a radioactive tracer. However, this isotope, as well as ^{137}Cs , has a long half-life (28.8 y) and both are present in the radioactive fallout that accompanies nuclear explosive tests. Both are considered to be very dangerous.

The chemistry of barium, Ba, is unexceptional but BaSO_4 is used as a contrast medium for X-ray diagnosis of the stomach because it is insoluble in hydrochloric acid. The Ba^{2+} ion is highly toxic and water-soluble compounds containing the ion should be handled cautiously.

Although radium, Ra, exists in uranium ores, the content is as low as 10^{-6} times that of uranium, U. Mr. and Mrs. Curie isolated a trace quantity of uranium chloride from tons of pitchblende in 1898. Elemental uranium was also isolated by Mrs. Curie via an amalgam. Although radium has historical importance in radiochemistry, it is no longer used as a radiation source.

? Exercise 5.2.2

Show examples of main group organometallic compounds which are often used in synthetic chemistry.

Answer

- Butyl lithium, LiBu,
- Grignard reagent, RMgBr,
- Triethylaluminum, AlEt₃,
- And diethyl zinc ZnEt₂.

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