Barium

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Barium is a chemical element with symbol **Ba** and atomic number 56. It is the fifth element in Group 2, a soft silvery metallic alkaline earth metal. Because of its high chemical reactivity, barium is never found in nature as a free element. Its hydroxide, known in pre-modern history as baryta, does not occur as a mineral, but can be prepared by heating barium carbonate.

The most common naturally occurring minerals of barium are barite (barium sulfate, $BaSO_4$) and witherite (barium carbonate, $BaCO_3$), both insoluble in water. The barium name originates from the alchemical derivative "baryta", from Greek βαρύς (*barys*), meaning "heavy." **Baric** is the adjective form of barium. Barium was identified as a new element in 1774, but not reduced to a metal until 1808 with the advent of electrolysis.

Barium has few industrial applications. Historically, it was used as a getter for vacuum tubes. It is a component of YBCO (high-temperature superconductors) and electroceramics, and is added to steel and cast iron to reduce the size of carbon grains within the microstructure. Barium compounds are added to fireworks to impart a green color. Barium sulfate is used as an insoluble additive to oil well drilling fluid, as well as in a purer form, as X-ray radiocontrast agents for imaging the human gastrointestinal tract. The soluble barium ion and soluble compounds are poisonous, and have been used as rodenticides.

Barium, $_{56}$Ba

General properties	
Name, symbol	barium, Ba
Appearance	silvery gray; with a pale yellow tint[1]
Barium in the periodic table	
Atomic number (Z)	56
Group, block	group 2 (alkaline earth metals), s-block
Period	period 6
Element category	alkaline earth metals
Standard atomic weight (±) (A_r)	137.327(7)[2]
Electron configuration	[Xe] $6s^2$
per shell	2, 8, 18, 18, 8, 2
Physical properties	
Phase	solid
Melting point	1000 K (727 °C, 1341 °F)
Boiling point	2118 K (1845 °C, 3353 °F)
Density near r.t.	

Characteristics

Physical properties

Barium is a soft, silvery-white metal, with a slight golden shade when ultrapure.[4]:2 The silvery-white color of barium metal rapidly vanishes upon oxidation in air yielding a dark gray oxide layer. Barium has a medium specific


Oxidized barium

weight and good electrical conductivity. Ultrapure barium is very difficult to prepare, and therefore many properties of barium have not been accurately measured yet.[4]:2

At room temperature and pressure, barium has a body-centered cubic structure, with a barium–barium distance of 503 picometers, expanding with heating at a rate of approximately 1.8×10^{-5}/°C.[4]:2 It is a very soft metal with a Mohs hardness of 1.25.[4]:2 Its melting temperature of 1,000 K (730 °C; 1,340 °F)[5]:4–43 is intermediate between those of the lighter strontium (1,050 K or 780 °C or 1,430 °F)[5]:4–86 and heavier radium (973 K or 700 °C or 1,292 °F);[5]:4–78 however, its boiling point of 2,170 K (1,900 °C; 3,450 °F) exceeds that of strontium (1,655 K or 1,382 °C or 2,519 °F).[5]:4–86 The density (3.62 g·cm^{-3})[5]:4–43 is again intermediate between those of strontium (2.36 g·cm^{-3})[5]:4–86 and radium (~5 g·cm^{-3}).[5]:4–78

Chemical reactivity

Barium is chemically similar to magnesium, calcium, and strontium, but even more reactive. It always exhibits the oxidation state of +2.[4]:2 Reactions with chalcogens are highly exothermic (release energy); the reaction with oxygen or air occurs at room temperature, and therefore barium is stored under oil or in an inert atmosphere.[4]:2 Reactions with other nonmetals, such as carbon, nitrogen, phosphorus, silicon, and hydrogen, are generally exothermic and proceed upon heating.[4]:2–3 Reactions with water and alcohols are very exothermic and release hydrogen gas:[4]:3

$$Ba + 2\ ROH \rightarrow Ba(OR)_2 + H_2\uparrow \text{ (R is an alkyl or a hydrogen atom)}$$

	3.51 g/cm^3
when liquid, at m.p.	3.338 g/cm^3
Heat of fusion	7.12 kJ/mol
Heat of vaporization	142 kJ/mol
Molar heat capacity	28.07 J/(mol·K)

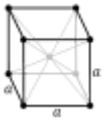
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	911	1038	1185	1388	1686	2170

Atomic properties

Oxidation states	**+2**, +1 (a strongly basic oxide)
Electronegativity	Pauling scale: 0.89
Ionization energies	1st: 502.9 kJ/mol 2nd: 965.2 kJ/mol 3rd: 3600 kJ/mol
Atomic radius	empirical: 222 pm
Covalent radius	215±11 pm
Van der Waals radius	268 pm

Miscellanea

Crystal structure	body-centered cubic (bcc) 
Speed of sound thin rod	1620 m/s (at 20 °C)
Thermal expansion	20.6 µm/(m·K) (at 25 °C)
Thermal conductivity	18.4 W/(m·K)
Electrical resistivity	332 nΩ·m (at 20 °C)

Barium reacts with ammonia to form complexes such as $Ba(NH_3)_6$.[4]:3

The metal is readily attacked by most acids. Sulfuric acid is a notable exception because passivation stops the reaction by forming the insoluble barium sulfate on the surface.[6] Barium combines with several metals, including aluminium, zinc, lead, and tin, forming intermetallic phases and alloys.[7]

Compounds

Barium salts are typically white when solid and colorless when dissolved, and barium ions provide no specific coloring.[8] They are denser than the strontium or calcium analogs, except for the halides (see table; zinc is given for comparison).

Barium hydroxide ("baryta") was known to alchemists, who produced it by heating barium carbonate. Unlike calcium hydroxide, it absorbs very little CO_2 in aqueous solutions and is therefore insensitive to atmospheric fluctuations. This property is used in calibrating pH equipment.

Volatile barium compounds burn with a green to pale green flame, which is an efficient test to detect a barium compound. The color results from spectral lines at 455.4, 493.4, 553.6, and 611.1 nm.[4]:3

Organobarium compounds are a growing field of knowledge: recently discovered are dialkylbariums and alkylhalobariums.[4]:3

Magnetic ordering	paramagnetic[3]
Young's modulus	13 GPa
Shear modulus	4.9 GPa
Bulk modulus	9.6 GPa
Mohs hardness	1.25
CAS Number	7440-39-3
	History
Discovery	Carl Wilhelm Scheele (1772)
First isolation	Humphry Davy (1808)

Most stable isotopes of barium

iso	NA	half-life	DM	DE (MeV)	DP
^{130}Ba	0.11%	$(0.5–2.7)\times10^{21}$ y	εε	2.620	^{130}Xe
^{132}Ba	0.10%	is stable with 76 neutrons			
^{133}Ba	syn	10.51 y	ε	0.517	^{133}Cs
^{134}Ba	2.42%	is stable with 78 neutrons			
^{135}Ba	6.59%	is stable with 79 neutrons			
^{136}Ba	7.85%	is stable with 80 neutrons			
^{137}Ba	11.23%	is stable with 81 neutrons			
^{138}Ba	71.70%	is stable with 82 neutrons			

Isotopes

Barium found in the Earth's crust is a mixture of seven primordial nuclides, barium-130, 132, and 134 through 138.[9] Barium-130 undergoes very slow radioactive decay to xenon-130 by double beta plus decay, and barium-132 theoretically decays like xenon-132, with half-lives a thousand times greater than the age of the Universe.[10] The abundance is ~0.1% that of natural barium.[9] The radioactivity of these isotopes is so weak that they pose no danger to life.

Of the stable isotopes, barium-138 composes 71.7% of all barium, and the lighter the isotope, the less abundant.[9]

In total, barium has about 50 known isotopes, ranging in mass between 114 and 153. The most stable metastable isotope is barium-133 with a half-life of approximately 10.51 years. Five other isotopes have half-lives longer than a day.[10] Barium also has 10 meta states, out of which barium-133m1 is the most stable with a half-life of about 39 hours.[10]

Source

- Wikipedia: Barium (https://en.wikipedia.org/wiki/Barium)