Samarium

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Samarium is a chemical element with symbol **Sm** and atomic number 62. It is a moderately hard silvery metal that readily oxidizes in air. Being a typical member of the lanthanide series, samarium usually assumes the oxidation state +3. Compounds of samarium(II) are also known, most notably the monoxide SmO, monochalcogenides SmS, SmSe and SmTe, as well as samarium(II) iodide. The last compound is a common reducing agent in chemical synthesis. Samarium has no significant biological role and is only slightly toxic.

Samarium was discovered in 1879 by the French chemist Paul Émile Lecoq de Boisbaudran and named after the mineral samarskite from which it was isolated. The mineral itself was earlier named after a Russian mine official, Colonel Vasili Samarsky-Bykhovets, who thereby became the first person to have a chemical element named after him, albeit indirectly. Although classified as a rare earth element, samarium is the 40th most abundant element in the Earth's crust and is more common than such metals as tin. Samarium occurs with concentration up to 2.8% in several minerals including cerite, gadolinite, samarskite, monazite and bastnäsite, the last two being the most common commercial sources of the element. These minerals are mostly found in China, the United States, Brazil, India, Sri Lanka and Australia; China is by far the world leader in samarium mining and production.

The major commercial application of samarium is in samarium-cobalt magnets, which have permanent magnetization second only to neodymium magnets; however, samarium compounds can withstand significantly higher temperatures, above 700 °C (1,292 °F), without losing their magnetic properties, due to the alloy's higher Curie point. The radioactive isotope samarium-153 is the major component of the drug samarium (^{153}Sm) lexidronam (Quadramet), which kills cancer cells in the treatment of lung cancer, prostate cancer, breast cancer and osteosarcoma. Another isotope, samarium-149, is a strong neutron absorber and is therefore added to the control rods of nuclear reactors. It is also formed as a decay product during the reactor operation and is one of the important factors considered in the reactor design and operation. Other applications of samarium include catalysis of chemical reactions, radioactive dating and an X-ray laser.

Samarium, $_{62}$Sm

General properties	
Name, symbol	samarium, Sm
Allotropes	α form
Appearance	silvery white
Samarium in the periodic table	
Atomic number (*Z*)	62
Group, block	group n/a, f-block
Period	period 6
Element category	□ lanthanide
Standard atomic weight (±) (A_r)	150.36(2)[1]
Electron configuration	[Xe] $4f^6$ $6s^2$
per shell	2, 8, 18, 24, 8, 2
Physical properties	
Phase	solid
Melting point	1345 K (1072 °C, 1962 °F)

Physical properties

Samarium is a rare earth metal having a hardness and density similar to those of zinc. With the boiling point of 1794 °C, samarium is the third most volatile lanthanide after ytterbium and europium; this property facilitates separation of samarium from the mineral ore. At ambient conditions, samarium normally assumes a rhombohedral structure (α form). Upon heating to 731 °C, its crystal symmetry changes into hexagonally close-packed (*hcp*), however the transition temperature depends on the metal purity. Further heating to 922 °C transforms the metal into a body-centered cubic (*bcc*) phase. Heating to 300 °C combined with compression to 40 kbar results in a double-hexagonally close-packed structure (*dhcp*). Applying higher pressure of the order of hundreds or thousands of kilobars induces a series of phase transformations, in particular with a tetragonal phase appearing at about 900 kbar.[3] In one study, the *dhcp* phase could be produced without compression, using a nonequilibrium annealing regime with a rapid temperature change between about 400 and 700 °C, confirming the transient character of this samarium phase. Also, thin films of samarium obtained by vapor deposition may contain the *hcp* or *dhcp* phases at ambient conditions.[3]

Samarium (and its sesquioxide) are paramagnetic at room temperature. Their corresponding effective magnetic moments, below $2\mu_B$, are the 3rd lowest among the lanthanides (and their oxides) after lanthanum and lutetium. The metal transforms to an antiferromagnetic state upon cooling to 14.8 K.[4][5] Individual samarium atoms can be isolated by encapsulating them into fullerene molecules.[6] They can also be doped between the C_{60} molecules in the fullerene solid, rendering it superconductive at temperatures below 8 K.[7] Samarium doping of iron-based superconductors – the most recent class of high-temperature superconductors – allows to enhance their transition temperature to 56 K, which is the highest value achieved so far in this series.[8]

External links

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

Boiling point	2173 K (1900 °C, 3452 °F)
Density near r.t.	7.52 g/cm^3
when liquid, at m.p.	7.16 g/cm^3
Heat of fusion	8.62 kJ/mol
Heat of vaporization	192 kJ/mol
Molar heat capacity	29.54 J/(mol·K)

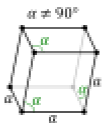
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	1001	1106	1240	(1421)	(1675)	(2061)

Atomic properties

Oxidation states	4, **3**, 2, 1 (a mildly basic oxide)
Electronegativity	Pauling scale: 1.17
Ionization energies	1st: 544.5 kJ/mol 2nd: 1070 kJ/mol 3rd: 2260 kJ/mol
Atomic radius	empirical: 180 pm
Covalent radius	198±8 pm

Miscellanea

Crystal structure	rhombohedral 
Speed of sound thin rod	2130 m/s (at 20 °C)
Thermal expansion	(r.t.) (α, poly) 12.7 µm/(m·K)
Thermal conductivity	13.3 W/(m·K)
Electrical resistivity	(r.t.) (α, poly) 0.940 µΩ·m

Magnetic ordering	paramagnetic[2]
Young's modulus	α form: 49.7 GPa
Shear modulus	α form: 19.5 GPa
Bulk modulus	α form: 37.8 GPa
Poisson ratio	α form: 0.274
Vickers hardness	410–440 MPa
Brinell hardness	440–600 MPa
CAS Number	7440-19-9
History	
Naming	after the mineral samarskite (itself named after Vasili Samarsky-Bykhovets)
Discovery and first isolation	Lecoq de Boisbaudran (1879)
Most stable isotopes of samarium	

iso	NA	half-life	DM	DE (MeV)	DP
^{144}Sm	3.08%	is stable with 82 neutrons			
^{145}Sm	syn	340 d	ε	–	^{145}Pm
^{146}Sm	syn	6.8×10^{7} y	α	2.529	^{142}Nd
^{147}Sm	15.00%	1.06×10^{11} y	α	2.310	^{143}Nd
^{148}Sm	11.25%	7×10^{15} y	α	1.986	^{144}Nd
^{149}Sm	13.82%	is stable with 87 neutrons			
^{150}Sm	7.37%	is stable with 88 neutrons			
^{151}Sm	syn	90 y	β^-	–	^{151}Eu
^{152}Sm	26.74%	is stable with 90 neutrons			
^{153}Sm	syn	46.284 h	β^-	–	^{153}Eu
^{154}Sm	22.74%	is stable with 92 neutrons			