Antimony

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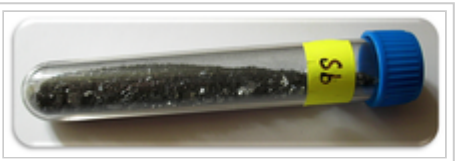
Antimony is a chemical element with symbol **Sb** (from Latin: *stibium*) and atomic number 51. A lustrous gray metalloid, it is found in nature mainly as the sulfide mineral stibnite (Sb_2S_3). Antimony compounds have been known since ancient times and were powdered for use as medicine and cosmetics, often known by the Arabic name, kohl.[3] Metallic antimony was also known, but it was erroneously identified as lead upon its discovery. In the West, it was first isolated by Vannoccio Biringuccio and described in 1540.

For some time, China has been the largest producer of antimony and its compounds, with most production coming from the Xikuangshan Mine in Hunan. The industrial methods for refining antimony are roasting and reduction with carbon or direct reduction of stibnite with iron.

The largest applications for metallic antimony is an alloy with lead and tin and the lead antimony plates in lead–acid batteries. Alloys of lead and tin with antimony have improved properties for solders, bullets and plain bearings. Antimony compounds are prominent additives for chlorine and bromine-containing fire retardants found in many commercial and domestic products. An emerging application is the use of antimony in microelectronics.

Characteristics

Properties



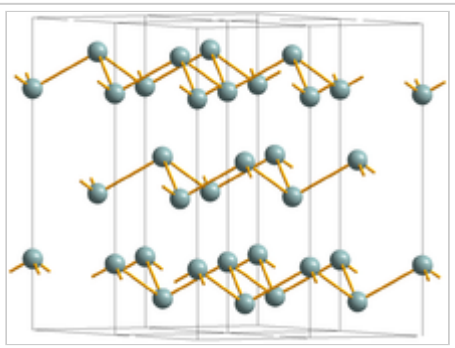
A vial containing the black allotrope of antimony

Antimony is in a pnictogen (a member of group 15) and has an electronegativity of 2.05. In accordance with periodic trends, it is more electronegative than tin or bismuth, and less electronegative than tellurium or arsenic. Antimony is stable in air at room temperature, but reacts with oxygen if heated to produce antimony trioxide, Sb_2O_3.[4]:758

Antimony, $_{51}$Sb

General properties	
Name, symbol	antimony, Sb
Appearance	silvery lustrous gray
Antimony in the periodic table	
Atomic number (Z)	51
Group, block	group 15 (pnictogens), p-block
Period	period 5
Element category	metalloid
Standard atomic weight (±) (A_r)	121.760(1)[1]
Electron configuration	[Kr] $4d^{10}$ $5s^2$ $5p^3$
per shell	2, 8, 18, 18, 5
Physical properties	
Phase	solid

Native antimony with oxidation products



Crystal structure common to Sb, AsSb and gray As

Antimony is a silvery, lustrous gray metalloid with a Mohs scale hardness of 3, which is too soft to make hard objects; coins of antimony were issued in China's Guizhou province in 1931 but the durability was poor and the minting was soon discontinued.[5] Antimony is resistant to attack by acids.

Four allotropes of antimony are known: a stable metallic form and three metastable forms (explosive, black and yellow). Elemental antimony is a brittle, silver-white shiny metalloid. When slowly cooled, molten antimony crystallizes in a trigonal cell, isomorphic with the gray allotrope of arsenic. A rare explosive form of antimony can be formed from the electrolysis of antimony trichloride. When scratched with a sharp implement, an exothermic reaction occurs and white fumes are given off as metallic antimony forms; when rubbed with a pestle in a mortar, a strong detonation occurs. Black antimony is formed upon rapid cooling of antimony vapor. It has the same crystal structure as red phosphorus and black arsenic, it oxidizes in air and may ignite spontaneously. At 100 °C, it gradually transforms into the stable form. The yellow allotrope of antimony is the most unstable. It has only been generated by oxidation of stibine (SbH_3) at −90 °C. Above this temperature and in ambient light, this metastable allotrope transforms into the more stable black allotrope.[6][7][8]

Elemental antimony adopts a layered structure (space group $R\bar{3}m$ No. 166) in which layers consist of fused, ruffled, six-membered rings. The nearest and next-nearest neighbors form an irregular octahedral complex, with the three atoms in each double layer slightly closer than the three atoms in the next. This relatively close packing leads to a high density of 6.697 g/cm^3, but the weak bonding between the layers leads to the low hardness and brittleness of antimony.[4]:758

Melting point	903.78 K (630.63 °C, 1167.13 °F)
Boiling point	1908 K (1635 °C, 2975 °F)
Density near r.t.	6.697 g/cm^3
when liquid, at m.p.	6.53 g/cm^3
Heat of fusion	19.79 kJ/mol
Heat of vaporization	193.43 kJ/mol
Molar heat capacity	25.23 J/(mol·K)

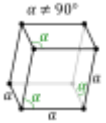
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	807	876	1011	1219	1491	1858

Atomic properties

Oxidation states	**5**, 4, **3**, 2, 1, −1, −2, **−3** (an amphoteric oxide)
Electronegativity	Pauling scale: 2.05
Ionization energies	1st: 834 kJ/mol 2nd: 1594.9 kJ/mol 3rd: 2440 kJ/mol (more)
Atomic radius	empirical: 140 pm
Covalent radius	139±5 pm
Van der Waals radius	206 pm

Miscellanea

Crystal structure	rhombohedral 
Speed of sound thin rod	3420 m/s (at 20 °C)

Isotopes

Antimony has two stable isotopes: ^{121}Sb with a natural abundance of 57.36% and ^{123}Sb with a natural abundance of 42.64%. It also has 35 radioisotopes, of which the longest-lived is ^{125}Sb with a half-life of 2.75 years. In addition, 29 metastable states have been characterized. The most stable of these is ^{120m1}Sb with a half-life of 5.76 days. Isotopes that are lighter than the stable ^{123}Sb tend to decay by β^+ decay, and those that are heavier tend to decay by β^- decay, with some exceptions.[9]

Occurrence

The abundance of antimony in the Earth's crust is estimated to be 0.2 to 0.5 parts per million, comparable to thallium at 0.5 parts per million and silver at 0.07 ppm.[10] Even though this element is not abundant, it is found in more than 100 mineral species. Antimony is sometimes found natively (e.g. on Antimony Peak), but more frequently it is found in the sulfide stibnite (Sb_2S_3) which is the predominant ore mineral.[10]

Source

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

Thermal expansion	11 µm/(m·K) (at 25 °C)
Thermal conductivity	24.4 W/(m·K)
Electrical resistivity	417 nΩ·m (at 20 °C)
Magnetic ordering	diamagnetic[2]
Young's modulus	55 GPa
Shear modulus	20 GPa
Bulk modulus	42 GPa
Mohs hardness	3.0
Brinell hardness	294–384 MPa
CAS Number	7440-36-0
History	
Discovery	3000 BC
First isolation	Vannoccio Biringuccio (1540)

Most stable isotopes of antimony

iso	NA	half-life	DM	DE (MeV)	DP
^{121}Sb	57.21%	is stable with 70 neutrons			
^{123}Sb	42.79%	is stable with 72 neutrons			
^{125}Sb	syn	2.7582 y	β^-	0.767	^{125}Te