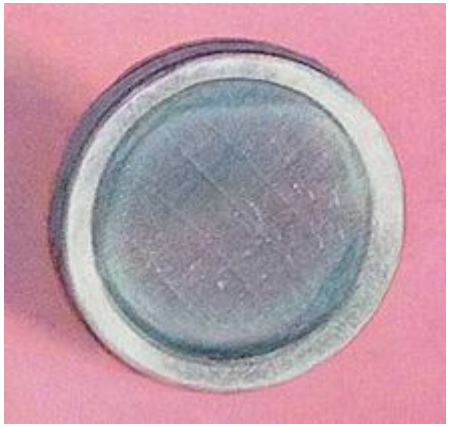
Polonium

From Wikipedia, the free encyclopedia

Polonium is a chemical element with symbol **Po** and atomic number 84. A rare and highly radioactive metal with no stable isotopes, polonium is chemically similar to selenium and tellurium, though it also shows resemblances to its horizontal neighbors thallium, lead, and bismuth due to its metallic character. Due to the short half-life of all its isotopes, its natural occurrence is limited to tiny traces of the fleeting polonium-210 (with a half-life of 138 days) in uranium ores, as it is the penultimate daughter of natural uranium-238. Though slightly longer-lived isotopes exist, they are much more difficult to produce. Today, polonium is more often produced in milligram quantities by the neutron irradiation of bismuth. Due to its intense radioactivity, which results in radiolysis of chemical bonds and immense radioactive self-heating, its chemistry has mostly been investigated on the trace scale only.

Polonium was discovered in 1898 by Marie and Pierre Curie, when it was chemically separated out of uranium ore and identified solely by its strong radioactivity: it was the first element to be so discovered. It was named after Marie Curie's homeland of Poland. Applications of polonium are sparse and dependent on its radioactivity: they include heaters in space probes, antistatic devices, and sources of neutrons and alpha particles. Its intense radioactivity makes it dangerously toxic to life.

Polonium, $_{84}$Po



General properties	
Name, symbol	polonium, Po
Allotropes	α, β
Appearance	silvery
Polonium in the periodic table	
Atomic number (*Z*)	84
Group, block	group 16 (chalcogens), p-block
Period	period 6
Element category	□ post-transition metal, but this status is disputed
Standard atomic weight (A_r)	(209)
Electron configuration	[Xe] $4f^{14}$ $5d^{10}$ $6s^2$ $6p^4$
per shell	2, 8, 18, 32, 18, 6

Characteristics

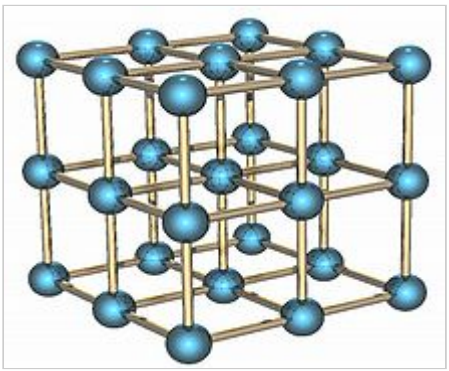
Isotopes

Polonium has 33 known isotopes, all of which are radioactive. They have atomic masses that range from 188 to 220 u. ^{210}Po (half-life 138.376 days) is the most widely available. The longer-lived ^{209}Po (half-life 125.2 ± 3.3 years, longest-lived of all polonium isotopes)[2] and ^{208}Po (half-life 2.9 years) can be made through the alpha, proton, or deuteron bombardment of lead or bismuth in a cyclotron.[3]

^{210}Po is an alpha emitter that has a half-life of 138.4 days; it decays directly to its stable daughter isotope, ^{206}Pb. A milligram (5 curies) of ^{210}Po emits about as many alpha particles per second as 5 grams of ^{226}Ra.[4] A few curies (1 curie equals 37 gigabecquerels, 1 Ci = 37 GBq) of ^{210}Po emit a blue glow which is caused by ionisation of the surrounding air.

About one in 100,000 alpha emissions causes an excitation in the nucleus which then results in the emission of a gamma ray with a maximum energy of 803 keV.[5][6]

Solid state form



The alpha form of solid polonium.

Polonium is a radioactive element that exists in two metallic allotropes. The alpha form is the only known example of a simple cubic crystal structure in a single atom basis, with an edge length of 335.2 picometers; the beta form is rhombohedral.[7][8][9] The structure of polonium has been characterized by X-ray diffraction[10][11] and electron diffraction.[12]

^{210}Po (in common with ^{238}Pu) has the ability to become airborne with ease: if a sample is heated in air to 55 °C (131 °F), 50% of it is vaporized in 45 hours to form diatomic Po_2 molecules, even though the melting point of polonium is 254 °C (489 °F) and its boiling point is 962 °C (1,764 °F).[13][14][1] More than one hypothesis exists for how polonium does this; one suggestion is that small clusters of polonium atoms are spalled off by the alpha decay.

Chemistry

The chemistry of polonium is similar to that of tellurium, although it also shows some similarities to its neighbor bismuth due to its metallic character. Polonium dissolves readily in dilute acids, but is only slightly soluble in alkalis. Polonium

Physical properties

Phase	solid
Melting point	527 K (254 °C, 489 °F)
Boiling point	1235 K (962 °C, 1764 °F)
Density near r.t.	alpha: 9.196 g/cm^3 beta: 9.398 g/cm^3
Heat of fusion	ca. 13 kJ/mol
Heat of vaporization	102.91 kJ/mol
Molar heat capacity	26.4 J/(mol·K)

Vapor pressure

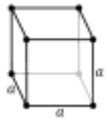
P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)				(846)	1003	1236

Atomic properties

Oxidation states	6, 5,[1] **4**, **2**, **−2** (an amphoteric oxide)
Electronegativity	Pauling scale: 2.0
Ionization energies	1st: 812.1 kJ/mol
Atomic radius	empirical: 168 pm
Covalent radius	140±4 pm
Van der Waals radius	197 pm

Miscellanea

Crystal structure	cubic α-Po
Crystal structure	rhombohedral β-Po



solutions are first colored in pink by the Po^{2+} ions, but then rapidly become yellow because alpha radiation from polonium ionizes the solvent and converts Po^{2+} into Po^{4+}. This process is accompanied by bubbling and emission of heat and light by glassware due to the absorbed alpha particles; as a result, polonium solutions are volatile and will evaporate within days unless sealed.[15][16]

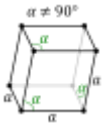
Compounds

Polonium has no common compounds, and almost all of its compounds are synthetically created; more than 50 of those are known.[17] The most stable class of polonium compounds are polonides, which are prepared by direct reaction of two elements. Na_2Po has the antifluorite structure, the polonides of Ca, Ba, Hg, Pb and lanthanides form a NaCl lattice, BePo and CdPo have the wurtzite and MgPo the nickel arsenide structure. Most polonides decompose upon heating to about 600 °C, except for HgPo that decomposes at ~300 °C and the lanthanide polonides, which do not decompose but melt at temperatures above 1000 °C. For example, PrPo melts at 1250 °C and TmPo at 2200 °C.[18] PbPo is one of the very few naturally occurring polonium compounds, as polonium alpha decays to form lead.[19]

Polonium hydride (PoH_2) is a volatile liquid at room temperature prone to dissociation; it is thermally unstable.[18] Water is the only other known hydrogen chalcogenide which is a liquid at room temperature; however this is due to hydrogen bonding. The two oxides PoO_2 and PoO_3 are the products of oxidation of polonium.[20]

Halides of the structure PoX_2, PoX_4 and PoF_6 are known. They are soluble in the corresponding hydrogen halides, i.e., $PoCl_X$ in HCl, $PoBr_X$ in HBr and PoI_4 in HI.[21] Polonium dihalides are formed by direct reaction of the elements or by reduction of $PoCl_4$ with SO_2 and with $PoBr_4$ with H_2S at room temperature. Tetrahalides can be obtained by reacting polonium dioxide with HCl, HBr or HI.[22]

Other polonium compounds include potassium polonite as a polonite, polonate, acetate, bromate, carbonate, citrate, chromate, cyanide, formate, (II) and (IV) hydroxides, nitrate, selenate, selenite, monosulfide, sulfate, disulfate and sulfite.[21][23]



Thermal expansion	23.5 µm/(m·K) (at 25 °C)
Thermal conductivity	20 W/(m·K) (?)
Electrical resistivity	α: 0.40 µΩ·m (at 0 °C)
Magnetic ordering	nonmagnetic
CAS Number	7440-08-6

History

Naming	after *Polonia*, Latin for Poland, homeland of Marie Curie
Discovery	Pierre and Marie Curie (1898)
First isolation	Willy Marckwald (1902)

Most stable isotopes of polonium

iso	NA	half-life	DM	DE (MeV)	DP
^{208}Po	syn	2.898 y	α	5.215	^{204}Pb
			β^+	1.401	^{208}Bi
^{209}Po	syn	(125.2±3.3) y[2]	α	4.979	^{205}Pb
			β^+	1.893	^{209}Bi
^{210}Po	trace	138.376 d	α	5.307	^{206}Pb

Source

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