Platinum

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Platinum is a chemical element with symbol **Pt** and atomic number 78. It is dense, malleable, ductile, highly unreactive, precious, gray-white transition metal. Its name is derived from the Spanish term *platina*, translated into "little silver".[2][3]

Platinum is a member of the platinum group of elements and group 10 of the periodic table of elements. It has six naturally occurring isotopes. It is one of the rarer elements in Earth's crust with an average abundance of approximately 5 μg/kg. It occurs in some nickel and copper ores along with some native deposits, mostly in South Africa, which accounts for 80% of the world production. Because of its scarcity in Earth's crust, only a few hundred tonnes are produced annually, and given its important uses, it is highly valuable and is a major precious metal commodity.

Platinum is one of the least reactive metals. It has remarkable resistance to corrosion, even at high temperatures, and is therefore considered a noble metal. Consequently, platinum is often found chemically uncombined as native platinum. Because it occurs naturally in the alluvial sands of various rivers, it was first used by pre-Columbian South American natives to produce artifacts. It was referenced in European writings as early as 16th century, but it was not until Antonio de Ulloa published a report on a new metal of Colombian origin in 1748 that it began to be investigated by scientists.

Platinum is used in catalytic converters, laboratory equipment, electrical contacts and electrodes, platinum resistance thermometers, dentistry equipment, and jewelry. Being a heavy metal, it leads to health issues upon exposure to its salts; but due to its corrosion resistance, metallic platinum has not been linked to adverse health effects.[4] Compounds containing platinum, such as cisplatin, oxaliplatin and carboplatin, are applied in chemotherapy against certain types of cancer.[5]

Characteristics

Platinum, $_{78}$Pt

General properties

Name, symbol	platinum, Pt
Appearance	silvery white

Platinum in the periodic table

Atomic number (Z)	78
Group, block	group 10, d-block
Period	period 6
Element category	□ transition metal
Standard atomic weight (±) (A_r)	195.084(9)[1]
Electron configuration	[Xe] $4f^{14}$ $5d^9$ $6s^1$
per shell	2, 8, 18, 32, 17, 1

Physical properties

Phase	solid
Melting point	2041.4 K (1768.3 °C, 3214.9 °F)
Boiling point	4098 K (3825 °C, 6917 °F)

Physical

Pure platinum is a lustrous, ductile, and malleable, silver-white metal.[6] Platinum is more ductile than gold, silver or copper, thus being the most ductile of pure metals, but it is less malleable than gold.[7][8] The metal has excellent resistance to corrosion, is stable at high temperatures and has stable electrical properties. Platinum reacts with oxygen slowly at very high temperatures.[9] It reacts vigorously with fluorine at 500 °C (932 °F) to form tetrafluoride.[10] It is also attacked by chlorine, bromine, iodine, and sulfur. Platinum is insoluble in hydrochloric and nitric acid, but dissolves in hot *aqua regia* to form chloroplatinic acid, H_2PtCl_6.[11]

Its physical characteristics and chemical stability make it useful for industrial applications.[12] Its resistance to wear and tarnish is well suited to use in fine jewelry.

Chemical

Platinum being dissolved in hot *aqua regia*

The most common oxidation states of platinum are +2 and +4. The +1 and +3 oxidation states are less common, and are often stabilized by metal bonding in bimetallic (or polymetallic) species. As is expected, tetracoordinate platinum(II) compounds tend to adopt 16-electron square planar geometries. Although elemental platinum is generally unreactive, it dissolves in hot *aqua regia* to give aqueous chloroplatinic acid (H_2PtCl_6):[13]

$$Pt + 4\ HNO_3 + 6\ HCl \rightarrow H_2PtCl_6 + 4\ NO_2 + 4\ H_2O$$

As a soft acid, platinum has a great affinity for sulfur, such as on dimethyl sulfoxide (DMSO); numerous DMSO complexes have been reported and care should be taken in the choice of reaction solvent.[14]

Isotopes

Density near r.t.	21.45 g/cm^3
when liquid, at m.p.	19.77 g/cm^3
Heat of fusion	22.17 kJ/mol
Heat of vaporization	510 kJ/mol
Molar heat capacity	25.86 J/(mol·K)

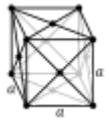
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	2330	(2550)	2815	3143	3556	4094

Atomic properties

Oxidation states	6, 5, **4**, 3, **2**, 1, −1, −2, −3 (a mildly basic oxide)
Electronegativity	Pauling scale: 2.28
Ionization energies	1st: 870 kJ/mol 2nd: 1791 kJ/mol
Atomic radius	empirical: 139 pm
Covalent radius	136±5 pm
Van der Waals radius	175 pm

Miscellanea

Crystal structure	face-centered cubic (fcc) 
Speed of sound thin rod	2800 m/s (at r.t.)
Thermal expansion	8.8 µm/(m·K) (at 25 °C)
Thermal conductivity	71.6 W/(m·K)
Electrical resistivity	105 nΩ·m (at 20 °C)

Platinum has six naturally occurring isotopes: ^{190}Pt, ^{192}Pt, ^{194}Pt, ^{195}Pt, ^{196}Pt, and ^{198}Pt. The most abundant of these is ^{195}Pt, comprising 33.83% of all platinum. It is the only stable isotope with a non-zero spin; with a spin of $^1/_2$, ^{195}Pt satellite peaks are often observed in ^{1}H and ^{31}P NMR spectroscopy (i.e., Pt-phosphine and Pt-alkyl complexes). ^{190}Pt is the least abundant at only 0.01%. Of the naturally occurring isotopes, only ^{190}Pt is unstable, though it decays with a half-life of 6.5×10^{11} years, causing an activity of 15 Bq/kg of natural platinum. ^{198}Pt can undergo alpha decay, but its decay has never been observed (the half-life is known to be longer than 3.2×10^{14} years); therefore, it is considered stable. Platinum also has 31 synthetic isotopes ranging in atomic mass from 166 to 202, making the total number of known isotopes 37. The least stable of these is ^{166}Pt, with a half-life of 300 µs, whereas the most stable is ^{193}Pt with a half-life of 50 years. Most platinum isotopes decay by some combination of beta decay and alpha decay. ^{188}Pt, ^{191}Pt, and ^{193}Pt decay primarily by electron capture. ^{190}Pt and ^{198}Pt have double beta decay paths.[15]

Magnetic ordering	paramagnetic
Tensile strength	125–240 MPa
Young's modulus	168 GPa
Shear modulus	61 GPa
Bulk modulus	230 GPa
Poisson ratio	0.38
Mohs hardness	3.5
Vickers hardness	400–550 MPa
Brinell hardness	300–500 MPa
CAS Number	7440-06-4
History	
Discovery and first isolation	Antonio de Ulloa (1748)

Most stable isotopes of platinum

iso	NA	half-life	DM	DE (MeV)	DP
^{190}Pt	0.012%	6.5×10^{11} y	α	3.252	^{186}Os
^{192}Pt	0.782%	is stable with 114 neutrons			
^{193}Pt	syn	50 y	ε	–	^{193}Ir
^{194}Pt	32.864%	is stable with 116 neutrons			
^{195}Pt	33.775%	is stable with 117 neutrons			
^{196}Pt	25.211%	is stable with 118 neutrons			
^{198}Pt	7.356%	is stable with 120 neutrons			

Occurrence

A native platinum nugget, Kondyor mine, Khabarovsk Krai

Platinum is an extremely rare metal,[16] occurring at a concentration of only 0.005 ppm in Earth's crust.[17][18] It is sometimes mistaken for silver (Ag). Platinum is often found chemically uncombined as native platinum and as alloy with the other platinum-group metals and iron mostly. Most often the native platinum is found in secondary deposits in alluvial deposits. The alluvial deposits used by pre-Columbian people in the Chocó Department, Colombia are still a source for platinum-group metals. Another large alluvial deposit is in the Ural Mountains, Russia, and it is still mined.[11]

In nickel and copper deposits, platinum-group metals occur as sulfides (e.g. (Pt,Pd)S), tellurides (e.g. PtBiTe), antimonides (PdSb), and arsenides (e.g. $PtAs_2$), and as end alloys with nickel or copper. Platinum arsenide, sperrylite ($PtAs_2$), is a major source of platinum associated with nickel ores in the Sudbury Basin deposit in Ontario, Canada. At Platinum,

Alaska, about 17,000 kg (550,000 ozt) had been mined between 1927 and 1975. The mine ceased operations in 1990.[19] The rare sulfide mineral cooperite, (Pt,Pd,Ni)S, contains platinum along with palladium and nickel. Cooperite occurs in the Merensky Reef within the Bushveld complex, Gauteng, South Africa.[20]

In 1865, chromites were identified in the Bushveld region of South Africa, followed by the discovery of platinum in 1906.[21] The largest known primary reserves are in the Bushveld complex in South Africa.[22] The large copper–nickel deposits near Norilsk in Russia, and the Sudbury Basin, Canada, are the two other large deposits. In the Sudbury Basin, the huge quantities of nickel ore processed make up for the fact platinum is present as only 0.5 ppm in the ore. Smaller reserves can be found in the United States,[22] for example in the Absaroka Range in Montana.[23] In 2010, South Africa was the top producer of platinum, with an almost 77% share, followed by Russia at 13%; world production in 2010 was 192,000 kg (423,000 lb).[24]

Platinum deposits are present in the state of Tamil Nadu, India.[25] and a MOU has been signed between Geological Survey of India with TAMIN – Tamil Nadu Minerals Ltd.[26]

Platinum exists in higher abundances on the Moon and in meteorites. Correspondingly, platinum is found in slightly higher abundances at sites of bolide impact on Earth that are associated with resulting post-impact volcanism, and can be mined economically; the Sudbury Basin is one such example.[27]

Source

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