

Vanadium

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Vanadium is a chemical element with symbol **V** and atomic number 23. It is a hard, silvery grey, ductile, and malleable transition metal. The elemental metal is rarely found in nature, but once isolated artificially, the formation of an oxide layer (passivation) stabilizes the free metal somewhat against further oxidation.

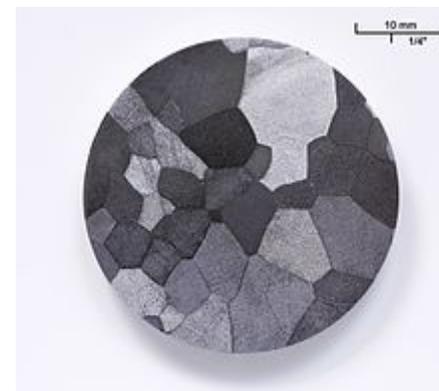
Andrés Manuel del Río discovered compounds of vanadium in 1801 in Mexico by analyzing a new lead-bearing mineral he called "brown lead", and presumed its qualities were due to the presence of a new element, which he named *erythronium* (derived from Greek for "red") since, upon heating, most of the salts turned red. Four years later, however, he was (erroneously) convinced by other scientists that erythronium was identical to chromium. Chlorides of vanadium were generated in 1830 by Nils Gabriel Sefström who thereby proved that a new element was involved, which he named "vanadium" after the Scandinavian goddess of beauty and fertility, Vanadís (Freyja). Both names were attributed to the wide range of colors found in vanadium compounds. Del Rio's lead mineral was later renamed vanadinite for its vanadium content. In 1867 Henry Enfield Roscoe obtained the pure element.

Vanadium occurs naturally in about 65 different minerals and in fossil fuel deposits. It is produced in China and Russia from steel smelter slag; other countries produce it either from the flue dust of heavy oil, or as a byproduct of uranium mining. It is mainly used to produce specialty steel alloys such as high-speed tool steels. The most important industrial vanadium compound, vanadium pentoxide, is used as a catalyst for the production of sulfuric acid.

Large amounts of vanadium ions are found in a few organisms, possibly as a toxin. The oxide and some other salts of vanadium have moderate toxicity. Particularly in the ocean, vanadium is used by some life forms as an active center of enzymes, such as the vanadium bromoperoxidase of some ocean algae.

Characteristics

Vanadium, $_{23}\text{V}$



General properties

Name, symbol	vanadium, V
Appearance	blue-silver-grey metal

Vanadium in the periodic table

Atomic number (<i>Z</i>)	23
Group, block	group 5, d-block
Period	period 4
Element category	☐ transition metal
Standard atomic weight (\pm) (<i>A</i> _r)	50.9415(1) ^[1]
Electron configuration	[Ar] 3d ³ 4s ²
per shell	2, 8, 11, 2

Physical properties

Phase	solid
Melting point	2183 K (1910 °C, 3470 °F)

Vanadium is a medium-hard, ductile, steel-blue metal. Some sources describe vanadium as "soft", perhaps because it is ductile, malleable and not brittle.^{[10][11]} Vanadium is harder than most metals and steels (see Hardnesses of the elements (data page) and iron). It has good resistance to corrosion and it is stable against alkalis and sulfuric and hydrochloric acids.^[12] It is oxidized in air at about 933 K (660 °C, 1220 °F), although an oxide passivation layer forms even at room temperature.

Isotopes

Naturally occurring vanadium is composed of one stable isotope, ⁵¹V, and one radioactive isotope, ⁵⁰V. The latter has a half-life of 1.5×10¹⁷ years and a natural abundance of 0.25%. ⁵¹V has a nuclear spin of 7/2, which is useful for NMR spectroscopy.^[13] Twenty-four artificial radioisotopes have been characterized, ranging in mass number from 40 to 65. The most stable of these isotopes are ⁴⁹V with a half-life of 330 days, and ⁴⁸V with a half-life of 16.0 days. The remaining radioactive isotopes have half-lives shorter than an hour, most below 10 seconds. At least four isotopes have metastable excited states.^[13] Electron capture is the main decay mode for isotopes lighter than ⁵¹V. For the heavier ones, the most common mode is beta decay. The electron capture reactions lead to the formation of element 22 (titanium) isotopes, while beta decay leads to element 24 (chromium) isotopes.

Source

- Wikipedia: Vandanium

Boiling point	3680 K (3407 °C, 6165 °F)
Density near r.t.	6.0 g/cm ³
when liquid, at m.p.	5.5 g/cm ³
Heat of fusion	21.5 kJ/mol
Heat of vaporization	444 kJ/mol
Molar heat capacity	24.89 J/(mol·K)

Vapor pressure

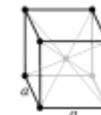
P (Pa)	1	10	100	1 k	10 k	100 k
at T (K)	2101	2289	2523	2814	3187	3679

Atomic properties

Oxidation states	5 , 4, 3, 2, 1, −1, −3 (an amphoteric oxide)
Electronegativity	Pauling scale: 1.63
Ionization energies	1st: 650.9 kJ/mol 2nd: 1414 kJ/mol 3rd: 2830 kJ/mol (more)
Atomic radius	empirical: 134 pm
Covalent radius	153±8 pm

Miscellanea

Crystal structure	body-centered cubic (bcc)
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Speed of sound thin rod	4560 m/s (at 20 °C)
Thermal expansion	8.4 μm/(m·K) (at 25 °C)
Thermal	30.7 W/(m·K)

conductivity	
Electrical resistivity	197 nΩ·m (at 20 °C)
Magnetic ordering	paramagnetic
Young's modulus	128 GPa
Shear modulus	47 GPa
Bulk modulus	160 GPa
Poisson ratio	0.37
Mohs hardness	6.7
Vickers hardness	628–640 MPa
Brinell hardness	600–742 MPa
CAS Number	7440-62-2

History

Discovery	Andrés Manuel del Río (1801)
First isolation	Nils Gabriel Sefström (1830)
Named by	Nils Gabriel Sefström (1830)

Most stable isotopes of vanadium

iso	NA	half-life	DM	DE (MeV)	DP
48V	syn	15.9735 d	β+	4.0123	48Ti
49V	syn	330 d	ε	0.6019	49Ti
50V	0.25%	1.5×10 ¹⁷ y	ε	2.2083	50Ti
			β [−]	1.0369	50Cr
51V	99.75%	is stable with 28 neutrons			