

Titanium

Ti

General Information

Discovery

Titanium was discovered by the Rev. W. Gregor in 1791 in Creed, Cornwall, and named by M.H. Klaproth in 1795 in Berlin. J.J. Berzelius isolated the metal in 1825. However, the pure metal was not made until 1910 by Hunter, who heated titanium(IV) chloride with sodium in a steel bomb.

Appearance

Titanium is a hard, lustrous, silvery metal.

Source

Titanium is the ninth most abundant element on Earth. It is almost always present in igneous rocks and the sediments derived from them. It occurs in the minerals rutile, ilmenite, and sphene, and is present in titanates and many iron ores. Titanium is produced commercially by reducing titanium(IV) chloride with magnesium.

Titanium(IV) oxide is produced commercially by either the Sulfate Process or the Chloride Process, both of which prepare titanium oxide from the mineral ilmenite.

Uses

Titanium is as strong as steel but much less dense. It is therefore important as an alloying agent with many metals including aluminium, molybdenum and iron. These alloys are principally used in aircraft and missiles as they are materials which have low density yet can withstand extremes of temperature. Titanium also has potential use in desalination plants which convert sea water to fresh water. The metal has excellent resistance to sea water, and so is used to protect the hulls of ships, and other structures exposed to sea water.

However, the largest use of titanium is in the form of titanium(IV) oxide, which is extensively used in both house paint and artists' paint. This paint is also a good reflector of infrared radiation and so is used in solar observatories where heat causes poor visibility.

Biological Role

Titanium has no known biological role, and is non-toxic. It can have a stimulatory effect, and is a suspected carcinogen.

General Information

Titanium burns in air and is the only element that burns in nitrogen. It is ductile only in an oxygen-free atmosphere. It is resistant to dilute hydrochloric and sulphuric acids, most organic acids, chlorine gas and chloride solutions. It is also resistant to alkalis. It combines with oxygen at red heat and with chlorine at 550K.

Physical Information

Atomic Number	22
Relative Atomic Mass ($^{12}\text{C}=12.000$)	47.88
Melting Point/K	1933
Boiling Point/K	3560
Density/kg m ⁻³	4540 (293K)
Ground State Electron Configuration	[Ar]3d ² 4s ²
Electron Affinity (M-M ⁻)/kJ mol ⁻¹	+2

Key Isotopes

Nuclide	⁴⁴ Ti	⁴⁶ Ti	⁴⁷ Ti	⁴⁸ Ti	⁴⁹ Ti	⁵⁰ Ti
Atomic mass	43.952	45.952	46.948	47.948	48.948	49.945
Natural abundance	0%	8.2%	7.4%	73.8%	5.4%	5.2%
Half-life	48 yrs	stable	stable	stable	stable	stable

Ionisation Energies/kJ mol⁻¹

M - M ⁺	658
M ⁺ - M ²⁺	1310
M ²⁺ - M ³⁺	2652
M ³⁺ - M ⁴⁺	4175
M ⁴⁺ - M ⁵⁺	9573
M ⁵⁺ - M ⁶⁺	11516
M ⁶⁺ - M ⁷⁺	13590
M ⁷⁺ - M ⁸⁺	16260
M ⁸⁺ - M ⁹⁺	18640
M ⁹⁺ - M ¹⁰⁺	20830

Other Information

Enthalpy of Fusion/kJ mol ⁻¹	20.9
Enthalpy of Vaporisation/kJ mol ⁻¹	425.5

Oxidation States

Main	Ti ⁴⁺
Others	Ti ⁻¹ , Ti ⁰ , Ti ⁺² , Ti ⁺³