

Titanium - Ti

Chemical properties of titanium - Health effects of titanium - Environmental effects of titanium

Atomic number	22
Atomic mass	47.90 g.mol ⁻¹
Electronegativity according to Pauling	1.5
Density	4.51 g.cm ⁻³ at 20°C
Melting point	1660 °C
Boiling point	3287 °C
Vanderwaals radius	0.147 nm
Ionic radius	0.09 nm (+2) ; 0.068 nm (+4)
Isotopes	8
Electronic shell	[Ar] 3d ¹ 4s ²
Energy of first ionisation	658 kJ.mol ⁻¹
Energy of second ionisation	1310 kJ.mol ⁻¹
Energy of third ionisation	2652 kJ.mol ⁻¹
Energy of fourth ionisation	4175 kJ.mol ⁻¹
Discovered by	William Gregor in 1791



Titanium

Chemical element, Ti, atomic number 22 and atomic weight 47.90. Its chemical behaviour shows many similarities with that of silica and zirconium, as an element belonging to the first transition group. Its chemistry in aqueous solution, especially in the lower oxidation states, has some similarities with that of chrome and vanadium. Titanium is a transition metal light with a white-silvery-metallic colour. It is strong, lustrous, corrosion-resistant. Pure titanium is not soluble in water but is soluble in concentrated acids. This metal forms a passive but protective oxide coating (leading to corrosion-resistance) when exposed to elevated temperatures in air but at room temperatures it resists tarnishing.

The main oxidation state is 4+, although the states 3+ and 2+ are also known, but are less stable. This element burns in the air when it's heated up to obtain the dioxide, TiO₂, and when it is combined with halogens. It reduces the water vapor to form the dioxide and hydrogen, and it reacts in a similar way with hot concentrated acids, although it forms trichloride with chlorhydric acid. The metal absorbs hydrogen to give TiH₂, and forms the nitride, TiN, and the carbide, TiC. Other known compounds are the sulfur TiS₂, as well as the lowest oxides, Ti₂O₃ and TiO, and the sulfurs Ti₂S₃ and TiS. Salts are known in the three oxidation states.

Applications

The titanium dioxide is extensively used as a white pigment in outside paintings for being chemically inert, for its great coating power, its opacity to UV light damage and its autodecleaning capacity. The dioxide was also used once as a bleaching and pacifying agent in porcelain enamels, giving them a final touch of great brightness, hardness and acid resistance. A typical lipstick contains 10% titanium.

Titanium alloys are characterized by very high tensile strength even at high temperatures, light weight, high corrosion resistance, and ability to withstand extreme temperatures. Due to these properties they are principally used in aircraft, pipes for power plants, armour plating, naval ships, spacecraft and missiles. Titanium is as strong as steel but 45% lighter.

In medicine titanium is used to make hip and knee replacements, pace-makers, bone-plates and screws and cranial plates for skull fractures. It has also been used to attach false teeth.

The alkaline earth titanates have some remarkable properties. The level of dielectric constants varies from 13 for the MgTiO₃, to various milliards for solid solutions of SrTiO₃ in BaTiO₃. The barium titanate also has a dielectric constant of 10.000 close to 120°C, which is its Curie point; it has low dielectric hysteresis. The ceramic transducers that contain barium titanate are favorably compared with Rochelle salt in terms of thermal stability and with quartz in terms of the strength of the effect and the capacity to form the ceramics in various forms. The compound has been used as ultrasonic vibrations generator and as a sound detector.

Titanium in the environment

Although it is not found unbound to other elements in nature, Titanium is the ninth most abundant element in the Earth's crust (0.63% by mass) and is present in most igneous rocks and in sediments derived from them. Important titanium minerals are rutile, brookite, anatase, ilmenite, and titanite. The chief mined ore, ilmenite, occurs as vast deposits of sand in Western Australia, Norway, Canada and Ukraine. Large deposits of rutile in North America and South Africa also contribute significantly to the world supply of titanium. World production of the metal is about 90.000 tonnes per year, and that of titanium dioxide is 4.3 million tonnes per year.

The titanium dioxide, TiO₂, is commonly found in a black or brownish form known as rutile. The natural forms that are less frequently found in nature are the anatase and the brookite. Both the pure rutile and the pure anatase are white. The black basic oxide, FeTiO₃, is found in the natural form as the natural mineral called ilmenite; this is the main commercial source of titanium.