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Vanadium (V^{23})

Properties

Vanadium is a silvery-gray metal with an atomic mass of 50.94 u. V has a density of 6.11 g/cm^3, a melting point of 1910 ^{o}C and a resistivity of 19.7 µOhm cm. Vanadium has a high tensile strength of ~ 800 MPa. It is hard and has a Brinell hardness of 600 - 742 MPa. Vanadium is ductile, malleable, and not brittle metal.

Vanadium forms chemical compounds in oxidation states +2, +3 and +5. Its standard electrode potential in respect to V^{+2} is -1.19V and V^{+3} is -0.84B. It has good resistance to corrosion, stable against alkalis, sulfuric and hydrochloric acids. V can be dissolved in nitric acid. Vanadium makes up 120 parts per million (ppm) of the Earth's crust.

Plating Solutions

Vanadium can be deposited from molten salt of sodium chloride containing in wt.%: vanadium (II) bromide – 7, potassium bromide – 33, sodium chloride – 27, magnesium chloride – 20, lithium chloride - 15 at temperature of 400 – 600 ^{o}C and current density of 1 – 500 mA/cm^2.

Vanadium pentoxide coatings can be electrodeposited at room temperature in an alkaline solution of methanol and vanadyl (III) acetyl acetonate with current density of 0.7 – 1.3 mA/cm^2 [1].

Electrodeposition of iron group (Fe, Co, Ni) – vanadium alloys can be performed from aqueous citrate and tartrate solutions [2, 3]. Addition of NH_3(aq.) to citrate solutions and increasing solution pH from 5.5 to 7 results in increased deposit V content up to ~14 wt% in Fe-V, Ni-V and Co-V alloys [2]. Co-V alloys can be electroplated from $CoCl_2$-NH_4VO_3 solutions, containing 15 g/L (Co+V) with NaKTartrate at pH≤ 1.0 at temperature of 20°C and current density of 50 to 70 mA/cm^2. The vanadium content in the deposit ranges from 2.0 to >25%, increasing as the solution V/Co ratio increased from 0.2 to 2, and the solution pH decreases from 2.0 to 0.4.

Applications

Approximately 85% of the vanadium produced is used as ferrovanadium, a steel additive [4]. Titanium-aluminum-vanadium alloy is used in jet engines and airframes for high-speed aircraft. Vanadium is also used to bond titanium to steel as well as in nuclear applications due to its low fission neutron cross-section. The most important industrial vanadium compound, vanadium pentoxide, is used in ceramics and as a catalyst for the production of sulfuric acid. Vanadium pentoxide (V_2O_5) has also attracted much attention due to its application as cathode material in batteries [5] and electrochromics [6]. Iron, nickel and cobalt alloys with vanadium are attractive due to higher recording capacities in memory chips that retain information, even with the power turned off [3].

References:

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