NANO3D SYSTEMS LLC
1110 NE Circle Blvd., ATAMI/Bldg. 11, Corvallis, Oregon 97330-4254
T 503-927-4766| F 541-758-9320| http://www.nano3dsystems.com

Zirconium (Zr^{40})

Properties

Zirconium is a silver-gray metal with an atomic mass of 91.22 u. Zr has a density of 6.52 g/cm^3, a melting point of 1857 ^{o}C and a resistivity of 42.1 μOhm cm. It is a very strong, malleable, ductile and lustrous metal. Zirconium has a Brinell hardness of 638 – 1880 MPa.

The most common compounds have Zr in the +4 state, while it also exists in many oxidation states such as -2, +1, +2, +3, and +4. Its standard electrode potential in respect to Zr^{+4} is -1.53V. Zirconium is chemically resistant in ambient atmosphere, bases and acids, but dissolves readily in concentrated hydrofluoric acid, sulfuric acid and hydrofluoric/nitric acid mixture. Zr is estimated to be at average concentration of 165 parts per million (ppm) in the Earth's crust.

Plating Solutions

Zirconium layers cannot be obtained from aqueous solutions because discharge potential of zirconium is much lower than hydrogen deposition potential and overpotential of hydrogen evolution on zirconium is relatively low. Molten salts [1-4], organic solvent solutions [5] and ionic liquids [6] can be used to electrodeposit zirconium.

Zirconium can be electroplated from molten salt under inert ambient, containing in wt.%: alkali metal fluoride - 30, zirconium fluoride – 40, alkali metal chloride – 30 at current density of 1000 – 5000 mA/cm^2. Zirconium can be also electrodeposited from molten salt under argon, consisting of 6 parts of zirconium potassium fluoride and 18 parts of sodium chloride at temperature of 750 – 800 ^{o}C and current density of 4200 mA/cm^2.

Zirconium can be electrodeposited from dimethyl sulfoxide (DMSO) solution, containing in g/l: Zr^{4+} - 10, $LiClO_4$ – 40 at temperature of 40 ^{o}C and current density of 4.4 mA/cm^2.

Applications

Zirconium and zirconium alloys are widely used in industry, due to their resistance to corrosion and tolerance of high temperatures. Since Zr does not absorb neutrons, it is an ideal material for tubes and other parts in nuclear power stations. Nuclear power generation applications account for more than 90% of commercial zirconium production. Other industries that use this metal for a variety of applications include solar power, chemical process, petrochemical, oil and gas, pharmaceutical, geothermal, mining, utilities, and many more.

References:

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