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Calcium (Ca^{20})

Properties

Calcium is a dull-gray alkaline metal, which is very ductile. Its properties are very similar to the heavier elements in its group, strontium, barium, and radium. Calcium has a density of 1.55 g/cm^3, a melting point of 842 ^oC and a resistivity of 3.36 μΩ cm. It is hard and has a Brinell hardness of 170-416 MPa.

At 3%, calcium is the fifth-most abundant element in the Earth's crust, and the third most abundant metal behind aluminum and iron. It is very reactive and forms a dark oxide-nitride layer when exposed to air. The most common calcium compounds on Earth is calcium carbonate, found in apatite, fluorite, gypsum, and anhydrite. The most common oxidation states for calcium are +1, and +2. The standard reduction potential for the Ca^{2+}/Ca couple being -2.868 volts. [1]

Plating Solutions

Calcium can be electroplated from $Ca(ClO_4)_2$ or $Ca(BF_4)_2$ solution in propylene/ ethylene carbonate at 100 °C at -1.5 volt vs Ca^{2+}/Ca [2].

Calcium phosphate coatings can be deposited using electrophoretic and electrodeposition techniques [3], for example, from supersaturated calcium phosphate electrolyte buffered at pH 7.4, temperature of 25-80^oC and current density of 8-120 mA/cm2 [4]. Calcium phosphates are the most important inorganic constituents of biological hard tissues that in the form of hydroxyapatite, with formula $Ca_{10}(PO_4)(OH)_2$, are present in bone and teeth.

Applications

The largest use of metallic calcium is in steelmaking, due to its strong chemical affinity for oxygen and sulfur. Its oxides and sulfides, once formed, give liquid lime aluminate and sulfide inclusions in steel which float out; on treatment, these inclusions disperse throughout the steel and became small and spherical, improving castability, cleanliness and general mechanical properties. Calcium compounds are widely used in many industries: in foods and pharmaceuticals for calcium supplementation, in the paper industry as bleaches, as components in cement and electrical insulators, and in the manufacture of soaps.

Calcium is an especially attractive alternative for rechargeable batteries as it is the fifth most abundant element in the Earth's crust. Comparing to aluminum and magnesium, its standard reduction potential is only 170 mV above that of lithium which makes it suitable for making batteries with a significantly larger cell potential than those elements. Finally, because of its lower polarizing character, the reaction kinetic is very faster than Mg^{2+} which causes better power performance [5]. Calcium is also used in maintenance-free automotive batteries, in which the use of 0.1% calcium–lead alloys instead of the usual antimony–lead alloys leads to lower water loss and lower self-discharging.

References:

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