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Selenium (Se^{34})

Properties

Selenium is a metalloid with an atomic mass of 78.97 u. Se has a density of 4.81 g/cm^3, a melting point of 221 ^{o}C. It has a Brinell hardness of 736 MPa. In its chemical behavior, selenium occupies an intermediate position with respect to sulfur and tellurium. It combines directly with many elements, e.g. oxygen, hydrogen, fluorine, chlorine, bromine and most metals. Selenium exists in several allotropic forms. The most stable form, crystalline hexagonal selenium, is metallic gray. Crystalline monoclinic selenium is a deep red color. Amorphous selenium is red in powder form and is black in vitreous form. Selenium burns in air and is uneffected by water, but dissolves in concentrated nitric acid, sulfuric acid and alkalis. The most common compounds have Se in the +2 and +4 states, while it is also found in other oxidation states such as -2, -1, +1, +2, +3, and +6. Its standard electrode potential in respect to Se^{+2} is -0.92V and + 0.85V for Se^{+4}. Se is estimated to be at average concentration of 50 parts per billion (ppb) in the Earth's crust.

Plating Solutions

Selenium can be electrodeposited from the aqueous solutions and ionic liquids, containing:

a) Example #1. Selenium dioxide – 350 g/l with wetting agent in aqueous solution at pH 8 - 8.8, temperature of 20 – 40 ^{o}C and current density of 0.5 – 2 mA/cm^2 or selenium dioxide and sodium citrate as support electrolyte with pH 4.3 at ambient temperature [1].

a) Example #2. Selenium in ionic liquids such as 1-butyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl)amide ([BMP]Tf_2N) at temperature of ≥100 °C [2] or 1-ethyl-3-methyl-imidazolium trifluromethylsulfonate at room and elevated temperatures [3].

Applications

The largest commercial use of Se, accounting for about 50% of consumption, is for the production of glass. It is also used as a catalyst in many chemical reactions. Selenium is used with bismuth in brasses and as an additive to stainless steel. When selenium is added to iron and copper based metals it improves their machinability. The lithium–selenium (Li–Se) battery is one of the most promising systems for energy storage in the family of lithium batteries [4]. The Li–Se battery is an alternative to the lithium–sulfur battery, with an advantage of high electrical conductivity. Copper indium gallium selenide is a material used in solar cells.

References:

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4. A. Eftekhari. *Sustainable Energy & Fuels*. **1**,14–29, 2017.

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