



Manganese (Mn²⁵)

Properties

Manganese is a silvery-gray metal with an atomic mass of 54.94 u. Mn has a density of 7.21 g/cm³, a melting point of 1246 °C and a resistivity of 185 μOhm cm. It has a Brinell hardness of 196 MPa.

The most common compounds have Mn in the +2, +4, +6 and +7 states, while it also exists in other oxidation states such as -3, -2, -1, +3, and +5. Its standard electrode potential in respect to Mn⁺² is -1.18V. Manganese is stable in dry air, but it can readily be dissolved in acids. Mn is estimated to be at average concentration of 1000 (0.1%) parts per million (ppm) in the Earth's crust.

Plating Solutions

Manganese can be electrodeposited from sulfate, sulfate-oxalate and sulfate-fluoride aqueous electrolytes ^[1], containing in g/l:

- Example #1.** Manganese sulfate – 225, ammonium sulfate – 135, oxalic acid – 20 g/l, selenic acid – 0.15 with pH 7.5-8.5 at temperature of 15-25 °C, current density of 40-50 mA/cm² and current efficiency of 80-90%.
- Example #2.** Manganese sulfate – 215, ammonium sulfate – 145, selenic acid – 0.15 with pH 6-7 at temperature of 15-25 °C, current density of ≤150 mA/cm² and current efficiency of 90-94%.
- Example #3.** Manganese sulfate– 180, ammonium sulfate – 130, hydrofluoric acid (40 wt.%) – 5 ml/l with pH 3-4 at temperature of 15-25 °C, current density of ≤500 mA/cm² and current efficiency of 45-47%.

To increase the cathodic efficiency of Mn electrodeposition, plating additives such as selenium and tellurium compounds can be used. Other plating additives include SO₂ ^[5] and Zn²⁺ ^[6].

Manganese and its alloys can be also deposited from ionic liquids, such as 1-ethyl-3-methylimidazolium bis (trifluoromethanesulfonyl) ^[7] and 1: 2 ratio of choline chloride and urea (ChCl-urea) ^[8] et al.

Applications

Manganese is a transition metal with important industrial alloy uses, particularly in stainless steels, that has accounted for most manganese demand, presently in the range of 85% to 90% of the total demand. Steel containing 8 to 15% of manganese has a high tensile strength of up to 863 MPa. The second largest application for manganese is in aluminium alloys. Aluminium with roughly 1.5% manganese has increased resistance to corrosion. Manganese alloys have also been demonstrated to have high Seebeck coefficients suitable for use as thermoelectric materials, have antiferromagnetic properties, and can be used to form dilute magnetic semiconductors.

References:

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