



Rhenium (Re⁷⁵)

Properties

Rhenium is a silvery-gray, heavy metal with an atomic mass of 186.2. Rhenium has a density of 21.0 g/cm³, a melting point of 3170 °C and a resistivity of 19.3 μOhm cm. It is relatively hard (i.e., electrolytically 494 Vickers compared to 525 for Cr), has a Brinell hardness of 1320 – 2500 MPa with high wear resistance and a low coefficient of friction.

Rhenium shows in its compounds a wide variety of oxidation states, ranging from -3 to +7 (-3, -1, 0, +2, +3, +4, +5, +6, +7). Its standard electrode potential in respect to Re⁺³ is +0.3V and Re⁺⁷ is +0.36B. It is chemically resistant in ambient atmosphere, hydrochloric, sulfuric and hydrofluoric acids, but dissolves readily in nitric acid. Rhenium is one of the rarest elements in the Earth's crust with an estimated average concentration of 1 part per billion (ppb).

Plating Solutions

Rhenium can be electroplated in acidic electrolytes, containing in g/l:

- Example #1. Potassium perrhenate – 15, sulfuric acid – 13 at temperature of 85 – 90 °C and current density of 15 mA/cm² with current efficiency of 15 – 19%.
- Example #2. Potassium perrhenate – 15, ammonium sulfate – 200 at temperature of 70 °C and current density of 10 - 15 mA/cm² with current efficiency up to of 40%.
- Example #3. Potassium perrhenate – 8, hydrofluoric acid – 25 at temperature of 80 °C and current density of 10 mA/cm² with current efficiency up to of 40%.

Rhenium alloys with iron-group metals (Ni, Co and Fe) can be fabricated by electroplating in aqueous acidic solutions. Ni-Re system is of interest because of the extensive mutual solubility, absence of compound formation, no phase transformations and less brittle than Co-Re since Ni is FCC in structure. The plating bath for co-deposition of rhenium (~60 wt.%) with nickel consists in g/l: nickel sulfate – 5, ammonium sulfate – 50 and potassium perrhenate – 4 at pH 2.5 and temperature of 70 °C with a current density of 20 mA/cm².

Pure Re films cannot be deposited from electroless plating baths. Iron-group metals can be added to the baths in order to start the induced co-deposition of Re. Re-Ni (Fe, Co) alloys with high rhenium content (60 - 75 at.%) were obtained. ^[1]

Applications

Rhenium is added to high-temperature super-alloys that are used to make jet engine parts, using 70% of the worldwide rhenium production.^[2] Another major application in catalysis, for example in platinum–rhenium catalysts which is primarily used in making lead-free & high-octane gasoline. Rhenium catalysts are very resistant to chemical poisoning from nitrogen, sulfur, phosphorus, and so they are used in certain kinds of hydrogenation reactions.

References:

1. A. Duhin, A. Inber, N. Eliaz and G. Gileadi. *Electrochim. Acta* **56**, 9637, 2011.
2. A.V. Naumov. *Russian Journal of Non-Ferrous Metals* **48** (6), 418–423, 2007.

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PER YOUR REQUIREMENTS**