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Magnesium (Mg^{12})

Properties

Magnesium is a gray-white alkaline earth metal. It has low density of 1.738 g/cm^3, a melting point of 650 ^{o}C and low resistivity of 4.39 μΩ·cm. It has a Brinell hardness of 260 MPa and high thermal conductivity of 156 W/(m K).

Magnesium has a low reactivity in the air due to formation of a passive oxide layer. Magnesium reacts with water at room temperature, though it reacts much more slowly than calcium, a similar group 2 metal. Magnesium also reacts exothermically with most acids. Magnesium is highly flammable, especially when powdered or shaved into thin strips. The most common oxidation states for Magnesium is +2, but others like +1 was also reported. [1] The standard reduction potential for the Mg^{2+}/Mg couple is -2.38 volts. Magnesium is the eighth most abundant element in the Earth's crust and the fourth most common element in the Earth (after iron, oxygen and silicon) making up 13% of the planet's mass and a large fraction of the planet's mantle. It is the third most abundant element dissolved in seawater, after sodium and chlorine.

Plating Solutions

Magnesium could be plated from different halides, organomagnesium halides, amidomagnesium halides and magnesium organoborates [2]. Magnesium electroplating solutions can be divided to aprotic and protic electrolytes.

a. Example #1: Mg^{2+}-amide-containing ionic liquid (N-methyl-N-propylpiperidinium bis [(trifluoromethyl)sulfonyl]amide)) with equimolar glyme (0.272 M) at room temperature with a current density of up to 6 mA cm^{-2} [3].
b. Example #2: Magnesium dibutyldiphenylborate solution in THF, at room temperature at a current density of 0.5 mA cm^{-2} [2].
c. Example #3: $MgCl_2$−$BiCl_3$ electrolyte (100 mM) and tetrabutylammonium (TBA) perchlorate (100 mM) in a solvent composition of 97% DME or THF and 3% hexanes at a current density of 0.2 mA cm^{-2} [4].

Applications

Magnesium is the third-most-commonly-used structural metal, following iron and aluminum. The main applications of magnesium are, in order: aluminium alloys, die-casting, removing sulfur in the production of iron and steel, and the production of titanium in the Kroll process. Magnesium is used in super-strong, lightweight materials and alloys. For example, when infused with silicon carbide nanoparticles, it has extremely high specific strength. Mg is one of the most interesting negative electrode materials for post lithium ion secondary batteries because of its price, natural abundance and high-theoretical capacity.

References:

[1] A. Fowler, "The Spectrum of Magnesium Hydride," *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, 2006.
[2] C. Liebenow, Z. Yang, and P. Lobitz, "The electrodeposition of magnesium using solutions of organomagnesium halides, amidomagnesium halides and magnesium organoborates," *Electrochem. commun.*, 2000.
[3] A. Kitada, Y. Kang, K. Matsumoto, K. Fukami, R. Hagiwara, and K. Murase, "Room Temperature Magnesium Electrodeposition from Glyme-Coordinated Ammonium Amide Electrolytes," *J. Electrochem. Soc.*, 2015.
[4] C. J. Barile, R. G. Nuzzo, and A. A. Gewirth, "Exploring salt and solvent effects in chloride-based electrolytes for magnesium electrodeposition and dissolution," *J. Phys. Chem. C*, 2015.

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