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Gallium (Ga^{31})

Properties

Gallium is a silvery-blue metal with an atomic mass of 69.72 u. Gallium has a density of 5.91 g/cm^3, a melting point of ~30 ^{o}C and a resistivity of 27.0 µOhm cm. It is soft and has a Brinell hardness of 56.8 – 68.7 MPa.

Gallium is found predominantly in +3 oxidation state. Its standard electrode potential in respect to Ga^{+3} is -0.53V and Ga^{+2} is +0.45B. It is chemically resistant in ambient atmosphere. Strong acids such as nitric and sulfuric acids dissolve gallium, forming gallium (III) salts. Alkaline hydroxide solutions also dissolve gallium, forming gallate salts. Gallium is a moderately abundant element in the Earth's crust. Its abundance has been estimated to be about 5 parts per million. It is found primarily in combination with zinc and aluminum ores.

Plating Solutions

Gallium can be electroplated in acidic and basic aqueous electrolytes, containing in g/l:

a) Example #1. Gallium chloride – 40, sulfamic acid – 125 at temperature of 25 ^{o}C, pH of 2 – 2.5 and current density of >200 mA/cm^2.
b) Example #2. Gallium chloride – 30, potassium pyrophosphate – 200 at temperature of 15 - 25 ^{o}C, pH of 10 – 10.5 and current density of 1 - 2 mA/cm^2.

Gallium thin film can be electrodeposited in chloline chloride ionic liquid at a plating current density of 0.5 to 10 mA/cm2 for 1 to 30 min at solution temperature of 65 C to 150 C [1]. Ga electroplating in solvent is typically slow, e.g. approximately 2 µm for 30 min (~0.067 µm/min) [2]. Electrophoretic deposition can be used to form gallium thin films with high deposition rate of ~ 0.6 µm/min [3].

Applications

Gallium is predominantly used in electronics. Gallium arsenide is used in microwave circuits, high-speed switching circuits, and infrared circuits. Gallium nitride and indium gallium nitride are used in blue & violet light-emitting diodes and diode lasers while copper-indium-gallium films are used for the fabrication of CIGS solar cells. Ga is also used in semiconductor technology as a dopant in semiconductor substrates. Gallium is used to make alloys such as galinstan with low melting points.

References:

1. R. N. Bhattacharya. US Patent 9,410,259 published Aug. 9, 2016.
2. M. Steichen, M. Thomassey, S. Siebenritt, and P.J. Dale. *Phys.Chem. Chem. Phys* **13**, 4292-4302, 2011.
3. H. Zhang, Y. Feng, S. Santhanagopalan, and D.D. Meng. *Micromachines* **6**, 32–41, 2015.

CONTACT NANO3D SYSTEMS LLC TO FORMULATE GALLIUM PLATING SOLUTION PER YOUR REQUIREMENTS