NANO3D SYSTEMS LLC
1110 NE Circle Blvd., ATAMI/Bldg. 11, Corvallis, Oregon 97330-4254
T 503-927-4766| F 541-758-9320| http://www.nano3dsystems.com

Arsenic (As^{33})

Properties

Arsenic is a silvery-white metalloid with an atomic mass of 74.92 u. As has a density of 5.73 g/cm^3, a melting point of 814 ^oC, and a Brinell hardness of 1440 MPa.

The most common compounds have As in the +3 and +5 states, while it also exists in other oxidation states such as -3, -2, -1, +1, +2, +4. Its standard electrode potential in respect to As^{+3} is +0.3V. Though stable in dry air, arsenic forms a golden-bronze tarnish upon exposure to humidity which eventually becomes a black surface layer. Arsenic makes arsenic acid with concentrated nitric acid, arsenous acid with dilute nitric acid, and arsenic trioxide with concentrated sulfuric acid. It does not react with water, alkalis, or non-oxidizing acids. As is estimated to be at average concentration of 1.5 parts per million (ppm) in the Earth's crust.

Plating Solutions

Arsenic can be electrochemically deposited from aqueous electrolytes, containing in g/l:

a) Example #1. Arsenic trioxide – 90, sodium hydroxide – 110 ml/l, potassium sodium tartrate tetrahydrate (Rochelle salt) - 80 with pH ~8 at temperature of 15-25 ^oC, current density of 10 – 20 mA/cm^2 and current efficiency of ~100%.
b) Example #2. Arsenic trioxide – 120, sodium cyanide – 3.7, sodium hydroxide – 120 at temperature of 15-25 ^oC and current density of 3 – 22 mA/cm^2.

Arsenic electrodeposition can be also performed from choline chloride/ethylene glycol deep eutectic solvent [1].

Molten salt with a melt composition of 6.4 wt.% Ba_2O_3, 20.3 wt.% NaF, 4.2% wt.% Ga_2O3 and 8.1 wt.% $NaAsO_2$ can be also used to electrodeposit GaAs at 720-760 ^oC [2].

Applications

The primary use of arsenic is in alloys of lead (for example, in car batteries). Arsenic is a common n-type dopant (arsine gas, AsH_3) in semiconductor technology. Gallium arsenide is the second most commonly used semiconductor after silicon. Other arsenic semiconductor alloys include InAs, AlAs and CdAs. Arsenic and its compounds, especially the trioxide, are used in the production of pesticides, treated wood products, herbicides, and insecticides. These applications are declining due to the toxicity of arsenic and its compounds.

References:

1. P.-K. Wang, Y.-T. Hsieh, and I.-W. Sun. *J. Electrochem. Soc.* **164**(4), D204-D209, 2017.
2. E. Pandey. “Handbook of semiconductor electrodeposition”. CRC Press, 1996.

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