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# Platinum ($Pt^{78}$)

## Properties

Platinum is a silvery-white precious transition metal with atomic mass of 195.1 u. Pt has a density of 21.45 g/cm$^3$, a melting point of 1768.3 $^o$C and a resistivity of 10.6 µOhm cm. It has a Brinell hardness of 300-500 MPa. Pure platinum is a lustrous, ductile, and malleable. It is more ductile than gold, silver or copper, but it is less malleable than gold.

Platinum is extremely rare metal, with an average abundance in Earth's crust of ~0.005 ppm. It has a very low reactivity and very resistant to corrosion even at high temperatures. Platinum is insoluble in hydrochloric and nitric acid, but dissolves in their mixture (hot aqua regia) to form chloroplatinic acid, $H_2PtCl_6$. It is also attacked by chlorine, bromine, iodine, and sulfur. The most common oxidation states for platinum are −3, −2, −1, +1, +2, +3, +4, +5, +6 [1]. The standard reduction potential for the $Pt^{2+}$/Pt couple is +1.2V.

## Plating Solutions

Platinum could be plated both electroless and electrolytic. Electroless plating baths can be acidic or alkaline, containing in g/l:

a. Example #1: $Pt(NH_3)_2(NO_2)_2$ - 2, hydrazine – 3 and acetic acid to adjust the pH to 3 at temperature of 50 °C. The deposition rate is 2 microns per hour [2].
b. Example #2: $Na_2Pt(OH)_6$ - 10, sodium hydroxide - 5, ethylenediamine - 10, and hydrazine – 1 at temperature of 35 °C. The deposition rate is 12.7 microns per hour [3] .

Platinum can also be electroplated in both acidic and alkaline baths, containing in g/l:

a. Example #1: $H_2Pt(OH)_6$ - 30, potassium acetate - 40, and potassium hydroxide – 60 at pH 13.5, room temperature and current density of 3 mA/cm$^2$ [4] .
b. Example #2: Ammonium chloroplatinate – 24, disodium phosphate – 130 at temperature of 60 $^o$C, pH 4.8 and current density of 4–5 mA/cm$^2$ with current efficiency of 75-85%.

## Applications

Platinum has widely been used as ornaments or accessories because of its clean and subdued shine, although it has a less loud color than gold. Platinum is also highly resistant to corrosion and gives a catalytic effect, and thus it can be adopted as materials for products used in industries such as vehicle emissions control devices, chemical production and petroleum refining et al. It also has applications in medicine and biomedicine, glassmaking equipment, investment, electrodes, anticancer drugs, oxygen sensors, spark plugs and turbine engines.

## References:

[1] J. Ghilane *et al.*, "Spectroscopic Evidence of Platinum Negative Oxidation States at Electrochemically Reduced Surfaces," 2007.
[2] I. Ohno, "Electroless Deposition of Palladium and Platinum," in *Modern Electroplating*, Hoboken, NJ, USA: John Wiley & Sons, Inc., 2011, pp. 477–482.
[3] G. Mallory and J. Hajdu, *Electroless plating: fundamentals and applications - Google Books*. 1990.
[4] K. Kitada and S. Yarita. US Patent 5529680, published 6/25/1996.

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