ANODIC DISSOLUTION RATE OF PLATINUM ZINC COMPOUND IN HYDROCHLORIC ACID

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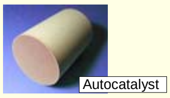
[Background]

There is growing demand for precious metals as functional materials.
To recover precious metals from scrap with less environmental load and without the least leftover, a novel efficient process is required.



New hydrometallurgical process for precious metals

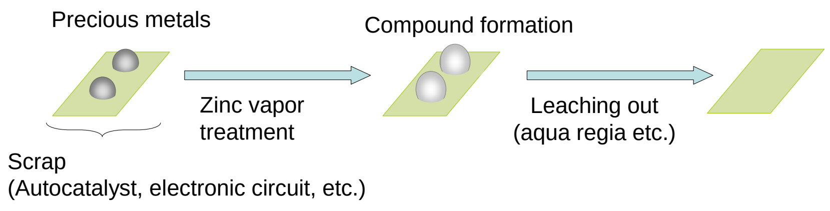


Fig. Recovery process of precious metals using zinc vapor

Compounds of precious metals with zinc dissolve faster than pure precious metals.

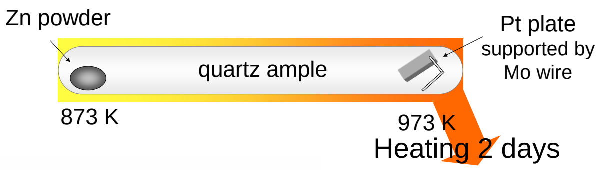
Reduction of costs and the effect on the environment
(Reduction of time and leaching solution)

To optimize the process, dissolution behaviors of precious metal compounds need to be investigated.

[Experimental]

Dissolution behavior of Pt-Zn compound was investigated.

Synthesis of Pt-Zn compound



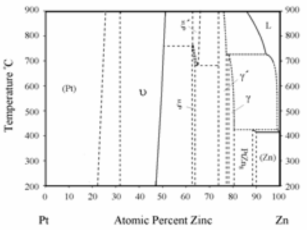


Fig. Pt-Zn Phase Diagram

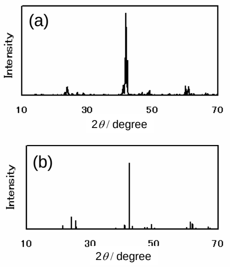
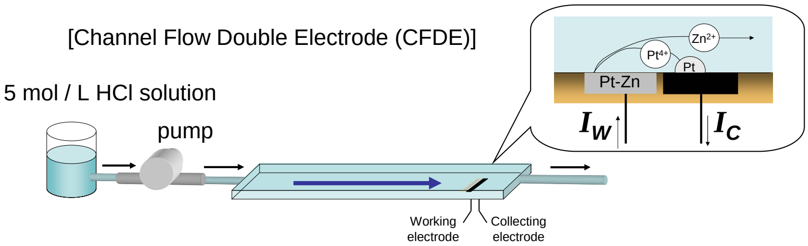


Fig. XRD patterns of (a) the synthesized sample and (b) Pt_5Zn_{21}

[1] Thaddeus B. Massalski et al. "BINARY ALLOY PHASE DIAGRAMS", ASM (1986)
[2] Srinivasa Thimmaiah et al. Solid State Sciences 5 (2003) 1309

Measurement of the dissolution rate of Pt-Zn compound



Working electrode (Pt-Zn) was polarized anodically.

- The working electrode current, I_W, is due to dissolutions of Pt and Zn ($I_{Pt} + I_{Zn}$).

Collecting electrode (glassy carbon) was polarized to reduce Pt ions that dissolved from the working electrode.

- The collecting electrode current, I_C, is I_{Pt} × collection efficiency, N.
- N can be calculated theoretically from geometries of electrodes[1].

The dissolution current of Pt from Pt-Zn can be derived from I_C and N

[1] K. Aoki, K. Tokuda, H. Matsuda, "Hydrodynamic Voltammetry at Channel Electrodes Part VII. Current Transients at Double Channel Electrodes", J. Electroanal. Chem., 195, 1985, 229-249.

[Results]

Potentiodynamic measurement

Dissolution rate of pure Pt

Potential of working electrode (Pt) was scanned from 0.2 V to 1.2 V at 10 mV・s^{-1}, while collecting electrode was kept at 0.1 V

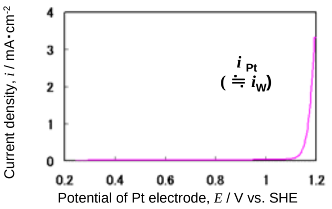


Fig. Polarization curve of Pt

The dissolution current density of Pt from working electrode, i_{Pt}, is derived according to the following equation :

$$i_{Pt} = I_C / NA$$

I_C : collecting electrode current, N : collection efficiency, A : surface area of the working electrode

i_{Pt} was in accordance with the current dencity at the working electrode, i_W.

The working electrode current is due to the dissolution of Pt

Dissolution rate of Pt_5Zn_{21}

Pt and Zn dissolution current from Pt_5Zn_{21} were measured in the same manner

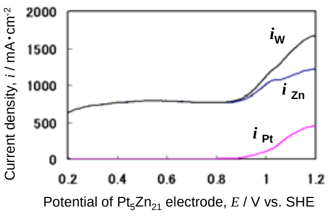


Fig. Polarization curves of Pt_5Zn_{21} (i_W) and dissolution rate of Zn (i_{Zn}) and Pt (i_{Pt})

The dissolution current density of Pt from Pt_5Zn_{21} working electrode, $i_{Pt} = I_C / NA$

The dissolution current density of Zn, $i_{Zn} = i_W - i_{Pt}$

At the potentials below 0.8 V, only Zn dissolves.

At the potentials above 0.8 V, Zn and Pt dissolve.

⇨ The dissolution rate of Pt is two orders of magnitude higher from the Pt-Zn compound than from pure Pt.

Potentiostatic measurement

Pt_5Zn_{21} working electrode was kept at a potential and time variations in the dissolution rates of Pt and Zn were investigated.

Dissolution of Pt_5Zn_{21} at 0.7 V

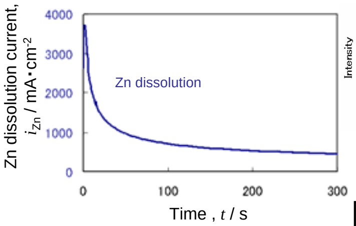


Fig. Time variations in the dissolution rate of Zn from Pt_5Zn_{21}

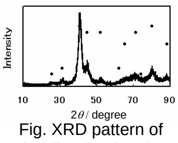


Fig. XRD pattern of the dissolved surface
● : PtZn (Ref. Nowotny et al. Monatsh. Chem., 83. 221 (1952))

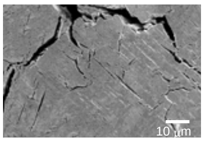


Fig. SEM image of the dissolved surface

⇨ Preferential dissolution of Zn results in υ phase ($Pt_5Zn_{21} \rightarrow$ υ)

Dissolution of Pt_5Zn_{21} at 1.0 V

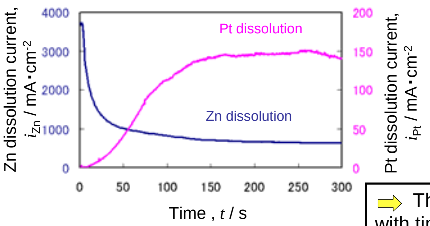


Fig. Time variations in dissolution rates of Pt and Zn from Pt_5Zn_{21}

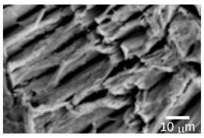


Fig. SEM image of the dissolved surface

⇨ The dissolution rate of Pt increases with time, accompanying an increase on the surface roughness.