New Separation and Recovery Process of Platinum Using Chlorinating Agents

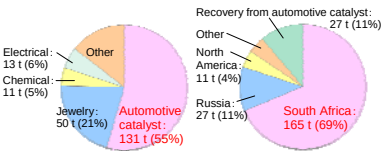
Chiyoko Horike and Toru H. Okabe*

Graduate Student, Graduate School of Engineering, The University of Tokyo; *Institute of Industrial Science, The University of Tokyo,

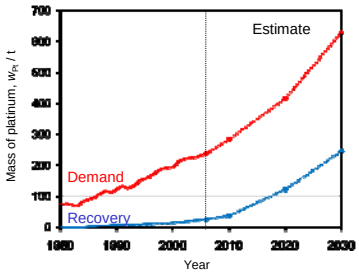
Introduction

Demand & Supply (Global scale, 2006)

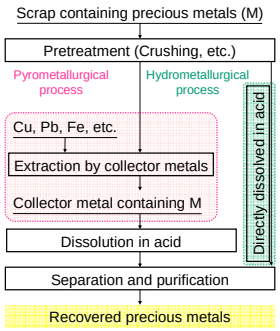
(a) Demand of Pt : 239 t (b) Supply of Pt : 240 t



World demand and recovery for Pt



Typical recovery process

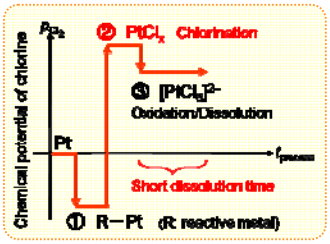


Pyrometallurgical process
- ○ High efficiency & speed
- × High energy cost & large facilities

Hydrometallurgical process
- ○ Low energy cost & easy handling
- × Long processing time & generation of a large amount of waste solution

Purpose of this study

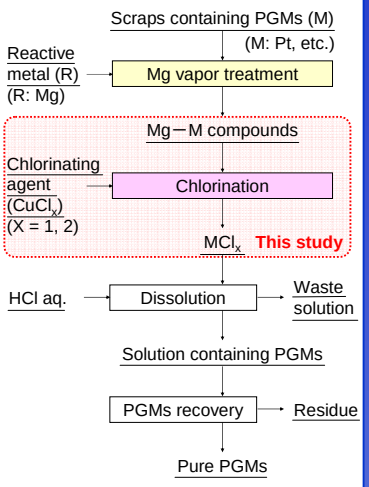
Development of a new process for an effective recovery of PGMs from scrap



① Compound formation under a highly reducing atmosphere
→ Pretreatment for selective and efficient dissolution of PGMs

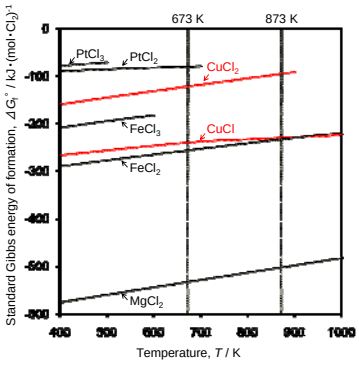
② Chlorination
→ High dissolution efficiency
→ Smaller amounts of acids required for dissolution
→ Fast dissolution

Flowchart of the new process

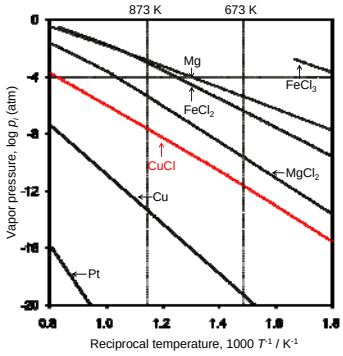


Thermodynamic analysis

Ellingham diagram



Vapor pressure of selected metals and chlorides



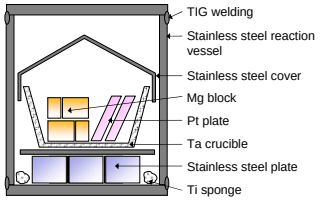
- Cl can be supplied by dissociation of chloride salts.
- Mg can be chlorinated faster than Pt.
- $CuCl_2$ is dissociated into Cl_2 and CuCl around 873 K.
- Vapor pressure of CuCl is lower than 10^{-4} atm.

⇒

- Reaction temperature was determined at 873 K.
- $CuCl_2$ and CuCl were selected for the chlorinating agent.

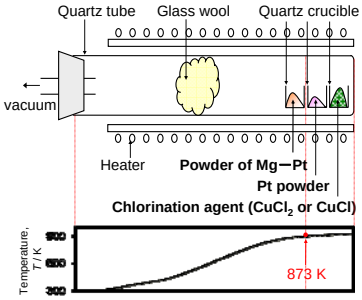
Experimental

Synthesis of Mg−Pt compounds



Pure Pt was reacted with molten Mg at 1173 K for 12 h.
→ Homogeneous Mg−Pt compounds were formed. (SEM, EDS, XRD)

Chlorination apparatus



Chlorination condition

Mg−Pt compounds and Pt were reacted with a chlorinating agent ($CuCl_2$ or CuCl) at 873 K for 3 h.

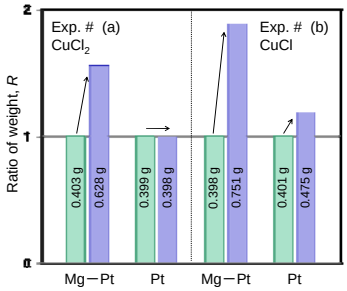
Exp. #	Chlorinating agent, i	Mass of chlorinating agent i, w_i / g	Amount of element in the chlorinating agent j, M_j / mol	
			Cu	Cl
a	$CuCl_2$	4.028	0.03	0.06
b	CuCl	5.944	0.06	0.06

Results and Discussion

Weight measurement

Comparison of weight change
Ratio of weight, $R = w_{o,i} / w_{f,i}$

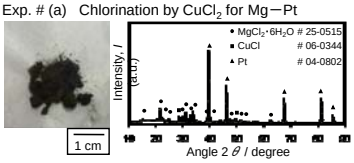
$w_{f,i}$: Weight of the feed samples
$w_{o,i}$: Weight of the obtained samples



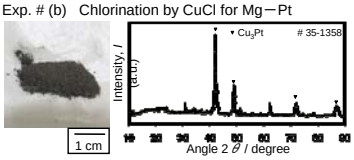
Mg alloying of Pt was clearly effective for the reaction with $CuCl_x$ (x = 1, 2).

XRD analysis

Exp. # (a) Chlorination by $CuCl_2$ for Mg−Pt



Exp. # (b) Chlorination by CuCl for Mg−Pt



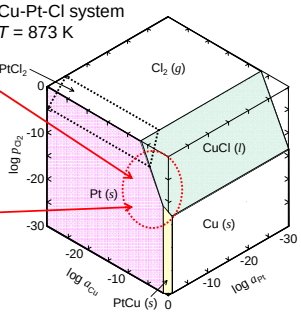
Composition analysis

Exp. #	sample	Chlorinating agent, i	Composition of element k, C_k (mass%)*			
			Mg	Pt	Cu	Cl
–	Mg−Pt	–	13.6	67.0	0	–
a	Chlorinated Mg−Pt	$CuCl_2$	10.7	47.6	4.8	Bal.
b	Chlorinated Mg−Pt	CuCl	7.1	36.1	17.0	Bal.

* Determined by ICP-AES analysis.

Potential diagram

Cu-Pt-Cl system
T = 873 K



The amount of Pt with an oxidation state of two was determined by calculation.
- Exp. # (a) 20%Pt
- Exp. # (b) 78%Pt

⇒ Pt can form complex compounds.

Conclusion

A fundamental technique that utilizes the selective alloying of PGMs with collector metals followed by chlorination/oxidation was studied.

- Mg−Pt compounds and Pt were chlorinated by using a chlorinating agent ($CuCl_2$ or CuCl) at 873 K for 3 h.
- Mg alloying of Pt was clearly effective for the reaction with $CuCl_x$ (x = 1, 2).
- After chlorination for Mg−Pt by $CuCl_2$, $MgCl_2$ and pure Pt were formed, and the obtained sample was contaminated by CuCl.
- After chlorination for Mg−Pt by CuCl, Cu−Pt was formed.

Future work

- Development of new supplying method of $CuCl_x$ (x = 1, 2) for more effective chlorination of Pt.
- Integration of the proposed chlorination method with the conventional dissolution methods in order to investigate practical processes.