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Thermodynamic study of extraction behavior for precious metals using phosphonium-based ionic liquids

Authors and affiliation

Ryoma Kinoshita[1], Yusuke Tsuchida[1], Masahiko Matsumiya[*1], and Yuji Sasaki[2]

[1] Graduate School of Environment and Information Sciences, Yokohama National University,
79-2 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan

[2] Nuclear Science and Engineering Directorate, Japan Atomic Energy Agency,
Tokai-mura, Naka-gun, Ibaraki, 319-1195, Japan

[*]E-mail: matsumiya-masahiko-dh@ynu.ac.jp

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Abstract (less than 300 words)

Room temperature ionic liquids (ILs) have unique physicochemical properties such as negligible vapor pressure, high ionic conductivity and wide electrochemical window. Compared to general organic solvent, the use of hydrophobic ILs is advantageous for operations at variable temperatures. On the other hand, it is important to develop the separation and recovery processes for platinum group metals such as platinum (Pt), Palladium (Pd), iridium (Ir) and ruthenium (Ru), and noble metals such as gold (Au). We had demonstrated that the recovery of Pt [1] and Ir [2] metals from phosphonium-based ILs and amine extractant by solvent extraction and direct electrodeposition so far.

In this study, several types of ILs consisting of triethyl-*n*-pentyl phosphonium; [P_{2225}^{+}], triethyl-*n*-octyl phosphonium; [P_{2228}^{+}], triethyl-*n*-dodecyl phosphonium; [P_{22212}^{+}], the other type of cations and bis(trifluoromethylaulfonyl)amide; [NTf_2^{-}] anion without extractant was applied for the solvent extraction of Au(III), Pt(IV), Pd(II), Ir(IV) and Ru(III). Under the experimental conditions, many phosphonium-based ILs exhibited a high extractability for Au(III). The extraction mechanism would be considered as anion exchange reaction; $[AuCl_4^{-}]_{aq}$ + $[P_{2225}][NTf_2]_{IL}$ ⇄ $[P_{2225}][AuCl_4]_{IL}$ + $[NTf_2^{-}]_{aq.}$

Moreover, thermodynamic results help predict the complexation behavior of the metal with extractants. In order to investigate the temperature effect on the extraction for Au(III), Pt(IV), Pd(II), Ir(IV) and Ru(III), the thermodynamic characteristics were evaluated at different operating temperatures (298-358 K). As a result, the Van't Hoff plot yielded a slope proportional to the enthalpy (ΔH) for Au(III), Pt(IV) and Pd(II) extractions. The complexation state of the extracted species would be also investigated by Raman spectroscopic analysis.

References

[1] M. Matsumiya, Y. Tsuchida, R. Kinoshita, Y. Sasaki, *J. Electrochem. Soc.*, (2021) in press.

[2] M. Matsumiya, R. Kinoshita, Y. Tsuchida, Y. Sasaki, *J. Electrochem. Soc.*, **168** (2021) 056501.

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