Overview of Solvent Extraction Methods and Development of Extraction Systems for Separation and Refining of Metal Resources

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General outline

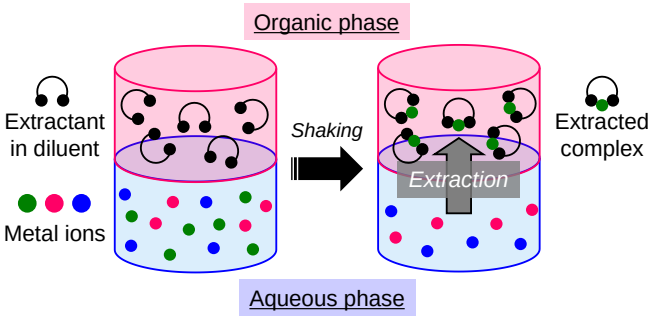
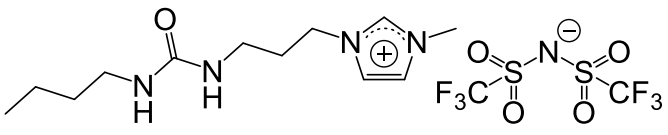


Fig. 1 Schematic diagram of solvent extraction.

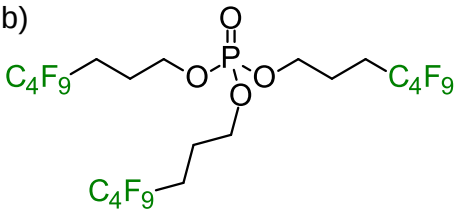
Securing a stable supply of rare metal resources, which are essential for high-tech industries, is an important global issue. An efficient method of recycling of from secondary resources is required to ensure a steady supply of these valuable metals and to allow for the recent global trends toward carbon neutrality. The separation and purification of metal ions are currently carried out using hydrometallurgical processes based precipitation crystallization, adsorption with ion exchange resins or activated carbon, electrolytic refining, cementation, solvent extraction. Among these separation methods, SX is widely used both in all over the world. Schematic diagram of SX method is shown in Fig. 1. Solvent extraction is a separation technique that uses a biphasic system with immiscible organic and aqueous solutions. Generally, the organic phase is an organic compound (extractant) with high affinity for a particular metal diluted with an organic solvent (diluent). The solvent extraction method has the advantages of high selectivity, high extraction capacity, operation at room temperature, closed system capability, and continuous operation. The selectivity of the solvent extraction process is highly dependent on the extractant; therefore, development of extractant is an important component of solvent extraction research. I have been developing extraction systems with high selectivity and extraction ability. In this lecture, I will first explain the basics of SX. Then, I will introduce the extraction systems I have researched and developed. One is the development of an extraction system using ionic liquids for the mutual separation of platinum and palladium (Fig. 2a). The other is the development of a superhydrophobic fluorous extraction system to solve a long-standing problem in SX: the formation of a third phase (Fig. 2b). I hope that today's lecture will get your interest in solvent extraction and the development of new extraction systems.

a)



Urea-introduced imidazolium-based ionic liquid

b)



Tris(nonafluoroheptyl) phosphate

Fig. 2 (a) Ionic liquid and (b) fluorous extraction systems presented in this lecture.

Index of literature

1. Yuki Ueda, Ayano Eguchi, Kohei Tokunaga, Kei Kikuchi, Tsuyoshi Sugita, Hiroyuki Okamura, Hirochika Naganawa, Urea-Introduced Ionic Liquid for the Effective Extraction of Pt(IV) and Pd(II) Ions, *Ind. Eng. Chem. Res.* **61**, 6640–6649 (2022). DOI: 10.1021/acs.iecr.2c00304
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