

## Development of Environmentally Benign Extractants and Construction of Highly Efficient Recycling Processes for Critical Metals

Principal Investigator: Masahito GOTO

Institution: Kyushu University

744 Motooka, Fukuoka-City, Fukuoka 809-0395, JAPAN

Tel: +81-92-802-2806 / Fax: +81-92-802-2810

E-mail: m-goto@mail.cstm.kyushu-u.ac.jp

### [Abstract]

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In developed countries, the 3Rs from secondary resources are being promoted to establish a resource cycle that reduces consumption of natural resources and actively uses recycled resources. The need to add value to waste as a secondary resource requires that rare metals, which are particularly expensive, be subject to recycling. Recovery of rare metals involves dismantling and concentrating the product and then using extraction and other wet smelting methods as with natural resources, but separating and recovering minute amounts of rare metals from large amounts of impure metals requires significant amounts of solvents and energy. For successful recycling, it is essential to establish a highly efficient rare metal separation and recovery process with minimal environmental impact.

In this project, we will develop an environmentally friendly extractant using an approach that differs significantly from conventional approaches, and develop an environmentally harmonized, high-efficiency recycling process that incorporates this extractant. This study focuses on the recycling of platinum group metals (Pt, Pd, and Rh) and rare metals from LiB, which are the most threatened resources and whose prices have recently skyrocketed.

With the aid of computational chemistry, we have established an efficient method for developing extractants that are environmentally friendly and exhibit high rare metal separation capability. We also established a highly efficient screening method for ionic liquids that combine low toxicity and high rare metal selectivity based on statistical machine learning. The newly developed extractants, ionic liquids, and deep eutectic solvents demonstrated high extraction ability for rare metals. Finally, we demonstrated the effectiveness of the newly developed technology by applying it to automotive exhaust gas catalysts and lithium-ion battery recycling.

### [References]

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