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Development of Concentrated and Selective Solvent Extraction of Lithium Halide

Shin-ichi Kondo

Faculty of Science, Yamagata University

Summary

Toward carbon neutrality, the demand for lithium-ion batteries has been glowing. The methods for extraction and purification of lithium salts from natural sources have been widely developed. In this study, the solid-liquid extraction of lithium salt, especially lithium chloride, by a ditopic receptor has been studied.

We have studied anion receptors bearing two urea units as recognition sites with high selectivity and binding ability for chloride anion. These receptors are significantly rigid to achieve such selectivity and binding ability, therefore the solubility of the receptors is quite low to be used for industrial applications. To improve the solubility in organic solvents, we prepared and evaluated receptors 3 and 4 bearing two urea functionalities connected with a flexible ether liker. The anion recognition abilities of 3 and 4 were slightly lower. The ether linker should be utilized as coordination sites for metal cations, indeed we found that receptors 3 and 4 can solubilize lithium chloride in organic solvents such as acetonitrile.

We evaluate the selectivity and efficiency of the solid-liquid extraction of lithium chloride by receptor 4b from the salt mixture by ion chromatography and ICP-MS. The high selectivity of lithium chloride over sodium, potassium, and calcium chloride and the low selectivity over magnesium chloride were found. Next, the selective solid-liquid extraction of lithium chloride from an artificial salt mixture in the Uyuni salt lake was carried out with receptor 4b. The ratio of lithium chloride was found to be 77.7 mol% by the extraction. Finally, solid-liquid extraction of lithium chloride from concentrated bittern was also examined. The ratios were significantly improved from 0.08–0.35 mol% to 19.34–36.80 mol% by the single extraction. Further purification should be achieved by repeated extraction.