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Development of Highly Efficient Separation Processes of Critical Metals from Sea Resources (II)

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Summary

Deep-sea minerals such as manganese nodules and crusts, which contain valuable critical metals, have been expected to be an alternative metal source. In recent years, a stable supply of rare metals indispensable for cutting-edge industries has been concerned all over the world. Then, the value of marine resources increases since valuable metals such as rare earth metals were recently identified in the marine minerals. However, there are some issues to be solved for their commercial use, that is, the economic evaluation for the metals of which prices wildly fluctuate and the establishment of the mining technology. Several studies on metal leaching from manganese nodules were reported, however there are few reports on the metal recovery from the leaching solutions. In this study, we focused on manganese nodules as a resource of critical metals and investigated the recovery of scandium, which is the most expensive rare earth metal.

In order to recover scandium, we have applied the novel amic-acid type extractant, *N*-[*N*,*N*-di(2-ethylhexyl)aminocarbonylmethyl]glycine (D2EHAG), which we synthesized last year. Liquid–liquid extraction of rare earth metal ions (scandium (Sc^{3+}), yttrium (Y^{3+}), lanthanides (La^{3+}, Nd^{3+}, Eu^{3+}, Dy^{3+})) was investigated using the extractant. Scandium (III) was selectively extracted from lanthanides at high acidic conditions ($0 < pH \leq 1.5$), and easily stripped by a mild acidic solution such as 1 mol dm^{-3} H_2SO_4. By comparing the extraction behavior with *N,N*-dioctyldiglycol amic acid (DODGAA), which has a similar molecular structure with D2EHAG, or a commercial alkyl monocarboxylic acid extractant Versatic 10, the peculiar affinity of D2EHAG to Sc was found by the chelating effect and the size recognition ability of D2EHAG. The extraction mechanism was examined, and it was proved that the trivalent scandium ion is extracted with four D2EHAG molecules by forming a stable metal complex. Therefore, the novel extractant was found to be useful for the recovery of scandium from sea natural resources.