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

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Summary

Deep-sea resources such as manganese nodules and crusts, which contain valuable critical metals, have been expected to be an alternative metal source. 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 depending on the global market situation and the establishment of the mining technology. Several studies on manganese nodules have been already reported, however there are few reports on the metal recovery from the leaching solutions. In this study, we focused on manganese nodules as a valuable resource of critical metals and investigated the recovery process of scandium, which is the most expensive rare earth metal.

In order to recover scandium, we have developed the polymer inclusion membrane (PIM) for the selective separation of Sc(III) from other REM ions. A comparison is made of the use of cellulose triacetate (CTA) based PIMs containing 2-thenoyltrifluoroacetone (HTTA), 2-ethylhexylphosphoric acid mono-2-ethylhexyl ester (PC-88A), N-[N,N-di(2-ethylhexyl) aminocarbonylmethyl]glycine (D2EHAG) or N-[N,N- di(2-ethylhexyl) aminocarbonylmethyl]phenylalanine (D2EHAF) as the carrier for the extraction of Sc(III). The potential of a PIM containing D2EHAF for the selective separation of Sc(III) from a feed solution containing similar concentrations of Y(III), La(III), Nd(III), and Dy(III) into a 0.5 mol L^{-1} sulfuric acid receiving solution has been demonstrated. In addition, the newly developed PIM containing D2EHAF exhibited excellent stability in 5 cycles of extraction and back-extraction of Sc(III) with a very little deterioration in its performance. The results obtained in this study indicate that the molecular structure of the carrier has a strong influence on membrane stability, and that the introduction of a phenyl group into the carrier molecule results in a significant improvement in the membrane stability.

The results outlined above demonstrate that the PIM containing D2EHAF offers considerable promise for the selective separation and pre-concentration of Sc(III) from leaching solutions of manganese nodules. It can be expected that the results obtained in this study will also be helpful in designing PIMs with improved stability which will be suitable for industrial and analytical separation applications.