Abstract #1202, 224th ECS Meeting, © 2013 The Electrochemical Society

Lithium Resources Recovery from Seawater by Electrodialysis using Novel Ion Exchange Membrane

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Lithium (Li), one of the 31 rare metal elements among the 112 known elements, is fast becoming a valuable commodity. As a means of addressing global warming, the world is increasingly turning to the use of Li-ion batteries in electric vehicles and as storage batteries in the home; therefore, there is a growing need for Li (Figure 1). Furthermore, as a fuel for fusion reactors, tritium is produced by the reaction of lithium with neutrons in a tritium-breeding material [1].

In South America, lithium is recovered from salt lakes and is currently being produced at the Atacama Salt Lake (SQM Co. Ltd. and Chemetall Co. Ltd.) in Chile and Hombre Muerto Salt Lake (FMC Co. Ltd.) in Argentina. The production in these two lakes accounts for approximately 70% of the world's lithium production [2-3]. Moreover, there are more than 100 salt lakes in the Puna plateau, which is surrounded by the Andes, located at altitudes greater than and above 3,500 m. Areas such as the Uyuni Salt Lake, Rincon Salt Lake, and Olaroz Salt Lake are expected to be developed for lithium production. Lithium reserves in these South American counties of Chile, Bolivia, and Argentina account for more than half of the world's lithium reserves and have outstanding lithium resources (brine water). Although lithium extraction from chloride brine water is easy, the quantity of natural resources is limited. On the other hand, the quantity of natural resources in sulfate brine water is large, but the processing technology has not yet been established. Recycling of used Li-ion batteries is another method for ensuring the supply of lithium resources. However, no lithium recycling technology has been established yet, and therefore, this process is not cost effective. As a result, urban mines have not been used effectively. Furthermore, it is estimated that there are virtually inexhaustible lithium resources in seawater, totaling approximately 230 billion tons, although lithium concentration is low. Therefore, lithium resource recovery from seawater using lithium adsorbents has been studied [4-5]. However, the efficiency of lithium absorption must be improved to enable cost-effective production.

Li procurement is a national policy issue worldwide. Currently, Japan relies solely on Li imports from overseas. Li is primarily recovered from salt lakes in South America but is also present in seawater. Thus, an efficient means for its stable recovery from seawater is highly desirable. Hoshino developed a novel Li-isotope separation technique that uses organic membranes impregnated with an ionic liquid [6-8]. This technique could also be used to recover Li from seawater. Building on this previous work, I report a new method for Li recovery from seawater by electrodialysis using an organic membrane impregnated with an ionic liquid.

I have proposed a new method for Li recovery from seawater by electrodialysis using an organic membrane impregnated with the ionic liquid PP13-TFSI. Only Li ions can significantly permeate this membrane and thus pass from the anode side to the cathode side. Because the other ions (Na, Mg, Ca and K) in seawater are much less capable of permeating the membranes, Li becomes selectively concentrated on the cathode side (Figure 1).

In the measurements of the ion concentration on the cathode side as a function of the duration of the applied dialysis voltage, the Li concentration increased with time, reaching 5.94% after 2 h. The other ions in seawater did not permeate the membrane. In measurements taken under the same conditions (2 V, 2 h) but with both ends of the impregnated membrane covered with a Nafion 324 overcoat to prevent outflow of the ionic liquid, the Li concentration increased to 22.2%.

This new recovery method shows good energy efficiency and is easily scalable. It should be suitable for use in seawater desalination plants and for the recycling of used Li-ion batteries. The recovered Li could then be put to many uses, including fusion reactor fuel production. This method may also be suitable for recovering other rare metals from seawater.

REFERENCES:

[1] T. Hoshino, K. Kato, Y. Natori, F. Oikawa, N. Nakano, M. Nakamura, K. Sasaki, A. Suzuki, T. Terai, K. Tatenuma, J. Nucl. Mater., 417 (2011) 684-687.
[2] P. W. Gruber, P. A. Medina, G. A. Keoleian, S. E. Kesler, M. P. Everson, T. J. Wallington, Journal of Industrial Ecology, 15 (2011) 760-775.
[3] W. Tahil, The Trouble with Lithium, © Meridian International Research, (2007) 1-22.
[4] R. Chitrakar, H. Kanoh, Y. Miyai, K. Ooi, Ind. Eng. Chem. Res., 40 (2001) 2054-2058.
[5] A. Umeno, Y. Miyai, N. Takagi, R. Chitrakar, K. Sakane, K. Ooi, Ind. Eng. Chem. Res., 41 (2002) 4281-4287.
[6] T. Hoshino, T. Terai, J. Nucl. Mater., 417 (2011) 696-699.
[7] T. Hoshino, T. Terai, Fusion Eng. and Des., 86 (2011) 2168–2171.
[8] T. Hoshino, Desalination, 317, (2013) 11-16.

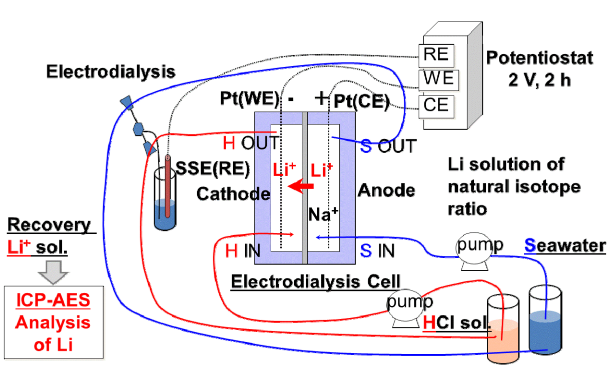

Figure 1 Principle of Li recovery method by electrodialysis.