

Ion-Exchange Properties of Zirconium Phosphate and Its Application for Recovery of Lithium from Seawater

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Summary

$\text{LiZr}_2(\text{PO}_4)_3$ is one of the good Li ion conductor. It has been definitely shown that metal substitution for Zr has a influence on the ion-exchange properties of $\text{LiZr}_2(\text{PO}_4)_3$.

$\text{Li}_{1+x}\text{M}_x\text{Zr}_{2-x}(\text{PO}_4)_3$ (L-MZP) [M:Fe, Cr, Al, Y, $0 \leq x \leq 2$] compounds were prepared by conventional solid state reactions, heating a mixture of Li_2O_3 , $\text{ZrO}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$, H_3PO_4 , and other metal oxides in a stoichiometric ratio at 1000°C . The ion-exchange experiments on L-MZP or H-MZP [$\text{H}_{1+x}\text{M}_x\text{Zr}_{2-x}(\text{PO}_4)_3$] were carried out by a batch method. A known quantity of L-MZP was suspended in 1 M HNO_3 solution. After the suspension was stirred at room temperature, H-MZP was separated by a membrane filter and dried in air. Thereafter, a 0.15g of H-MZP was immersed in buffer solution, containing 5 mM of Li^+ and/or Na^+ . The concentration of alkaline metals in the filtrate was determined by adsorption spectrophotometry. The amounts of adsorbed metal ions were calculated from initial and final concentrations in buffer solutions.

The lithium ion conducting material, $\text{Li}_{1+x}\text{M}_x\text{Zr}_{2-x}(\text{PO}_4)_3$, is a solid solution in which replacement of Zr^{4+} by other metal ion species takes place. The species and amount of metal ions, introduced into the $\text{A}_{1+x}\text{M}_x\text{Zr}_{2-x}(\text{PO}_4)_3$ (A:H, Li), strongly affects the ion-exchange properties of the materials. H-CrZP and H-FeZP (A:H and M=Cr or Fe) showed high Li^+ selectivity in buffer solution. In addition, the structures of H-CrZP were extremely stable in acid solution, in the region of $0 \leq x \leq 2$. The material H-CrZP with $x=1.5$ has been applied to recovery of lithium from Yamaga hot spring and Oita sea water. This material showed extremely high Li^+ selectivity in these natural water.