Synthesis of $LiM_xCo_{1-x}O_2$ by Sol-Gel Method Using Acrylic Acid and Its Electrochemical Characterizations

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Intorduction

High energy density, high rate capacity, and room-temperature operating power sources are strongly needed for various applications such as self powering micro-electronics components, portable electronics, and electric vehicles. Among competing systems, rechargeable lithium batteries show highest energy density. Owing to the high reducing power of lithium that leads to large cell voltage up to the 4V range. Despite the high cost and toxicity of cobalt, $LiCoO_2$ is the cathode material used in almost all commercially available Li-ion batteries to date, due to its straightforward synthesis allowing for excellent performances.

Experimental

$LiCoO_2$ was prepared by sol-gel synthesis method using acrylic acid a a chelating agent. The stoichiometric ratio of lithium acetate, cobalt acetate, and another metal compounds with a cationic ratio of Li:(Co + M) = 1 : 1 was dissolved in water with acrylic acid and stirred for 2 hrs in order to obtain a homogeneous solution.
The precursor solution was placed on a rotary vacuum evaporator to evaporate the water slowly at 80℃. Thus obtained xerogel was heated in air at 500℃ for 6 hrs and then cooled to room temperature. The sub-micron sized $LiCoO_2$ powders doped with M was prepared by heat-treating it at a temperature of 800℃ for 24hrs in air. Prepared powder was examined physical properties and electrochemical properties. The positive electrodes were composed of 85wt.% active material, 10wt.% acetylene black conductor, and 5wt.% polyvinyliden fluoride binder. The electrolyte was a 1:1:1 mixture of ethylene carbonate(EC), dimethyl carbonate(DMC) and ethylmethyl carbonate(EMC) containing 1M $LiPF_6$.

Results and Discussion

Prepared powder was uniform sized on 200-300nm and size distribution was changed according to doped metal sources and amount. The X-ray diffraction patterns of $LiCoO_2$ with doped Mg amount are given in Fig. 1. Structure of all of powders was layered $LiCoO_2$, despite of the involving Mg amount. The effect of doped Mg to $LiCoO_2$ is made clearer by comparison of the two cyclic voltammograms of $LiCoO_2$ and $LiMg_{0.01}Co_{0.99}O_2$ in Fig. 2 and Fig. 3. Curves in Fig. 3 show voltammograms were more stable cycling performance. And also its specific capacity was shows higher. Another doped metal sources such as Ag and Ru have a similar effect on $LiCoO_2$ in the range of 0.01-0.05mole.

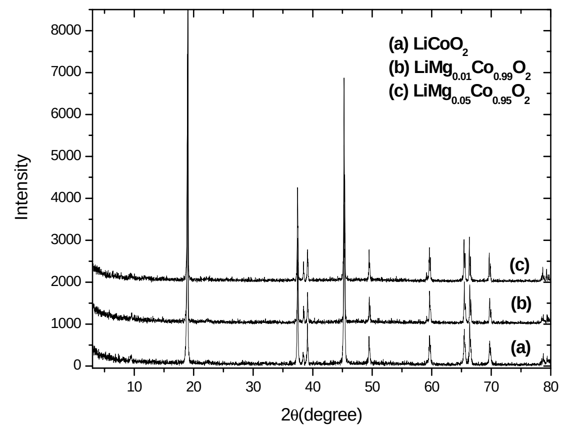

Fig. 1. XRD patterns of $LiCoO_2$(doped with Mg) synthesized by sol-gel method.

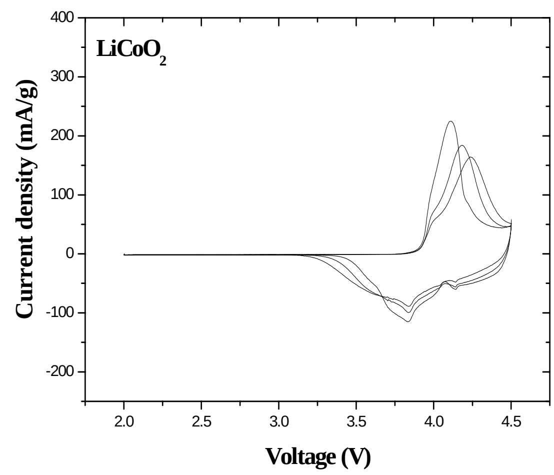

Fig. 2. Cyclic voltammogram of $LiCoO_2$ synthesized by sol-gel method.

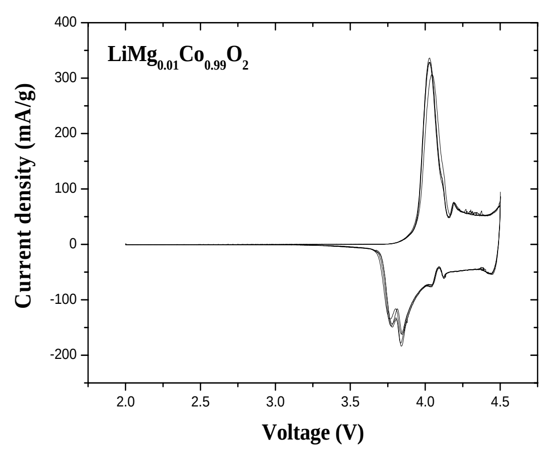

Fig. 3. Cyclic voltammogram of $LiMg_{0.01}Co_{0.99}O_2$ synthesized by sol-gel method.