

Electrochemical performances of the acid-treated and ceramic-coated $0.3\text{Li}_2\text{MnO}_3 \cdot 0.7\text{LiMn}_{0.60}\text{Ni}_{0.25}\text{Co}_{0.15}\text{O}_2$ cathode materials for Li-ion batteries

Mansoo Choi, Bong-Soo Jin, Hyun-Soo Kim*
 Battery Research Center, Korea Electrotechnology
 Research Institute, Changwon 642-120 Korea

In order to deploy lithium ion batteries as the promising energy storage devices for electric storage system and electric vehicle, it is essential to develop the electrode with a high energy density and long cycle life, durability and safety. Over the past years, there have made an effort to develop a Li and Mn-rich based layered electrode materials in attempts to find less expensive and safer cathode materials. In terms of energy density, the lithium-excess layered oxides represented by two-component, for instance, $x\text{Li}_2\text{MnO}_3 \cdot (1-x)\text{LiMO}_2$ (M=Mn, Co, Ni) have been widely considered as potential cathode materials for Li-ion battery due to the high specific capacity (~250 mAh/g). The two lithium ions extracted from Li_2MnO_3 unit on initial charge cannot be reinserted on the subsequent discharge into the MnO_2 . It means that there is irreversible capacity loss on the initial cycle.

Recently, it has reported that the lithium ions resulted in net loss of lithia (Li_2O) from Li_2MnO_3 component can be removed by an acid treatment. The chemical activation of $x\text{Li}_2\text{MnO}_3 \cdot (1-x)\text{LiMO}_2$ electrodes are favorable to eliminate the first cycle capacity loss of the electrode. However, the acid-treated electrode is damaged on the surface and it leads to inferior long-term cycling stability and lose capacity more rapidly than untreated electrode. The coating method is generally employed in order to modify the surface of the electrode with other metal oxides. An atomic layer deposition (ALD) is the powerful tool to coat uniform and thin films on the electrode with atomic thickness using sequential, self-limiting surface reactions. Recently, other groups reported that ALD coated on electrode have shown enhanced both the durability and safety. Another exceptional benefit of ALD is that it can deposit directly on as-formed electrodes.

In this work, we have carried out acid-treatment of $0.3\text{Li}_2\text{MnO}_3 \cdot 0.7\text{LiMn}_{0.60}\text{Ni}_{0.25}\text{Co}_{0.15}\text{O}_2$ by using nitric acid (HNO_3) to remove the Li_2O which is irreversible capacity loss in initial activation process. The ALD is also employed to coat the uniform Al_2O_3 thin layer and improve the cycling stability and rate capability of the electrode.

The $0.3\text{Li}_2\text{MnO}_3 \cdot 0.7\text{LiMn}_{0.60}\text{Ni}_{0.25}\text{Co}_{0.15}\text{O}_2$ powders were prepared by a co precipitation method. A transition metal (Mn, Ni, Co) carbonate solution was prepared by dissolving a desired amount in deionized water and reacted in Couette-Taylor reactor. The co-precipitated powders were then dried in air at 100°C in an oven overnight subsequent to washing with deionized water and filtering the powders. The co-precipitated metal carbonates were ground with $\text{LiOH} \cdot \text{H}_2\text{O}$ and then fired at

500°C for 8hr and 900°C for 6hr. The $0.3\text{Li}_2\text{MnO}_3 \cdot 0.7\text{LiMn}_{0.60}\text{Ni}_{0.25}\text{Co}_{0.15}\text{O}_2$ powders were preconditioned by 0.1M HNO_3 with constant stirring. The products were washed, filtered and dried at 100°C overnight. Thereafter, the powders were re-fired at 300°C for 5hr to remove the residual surface and occluded water. The Al_2O_3 films were directly deposited on the as-fabricated electrode³.

The details of results will be discussed in the meeting.

References:

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