Synthesis and Characterization of Co Doped Nickel-Manganese based Spinel-Layered Mixed Structure as Cathode Active Materials

Jae-Min Choi¹, In-Hyung Choi¹, Yun Ju Hwang², Ho-Saeng Jang¹, Jeong-Sook Jeon¹, In-Ho Park¹, Kee-Suk Nahm¹,²,³,*

¹Department of Energy Storage·Conversion Engineering, Chonbuk National University, Jeonju, Republic of Korea
²R&D Education Center for Fuel Cell Materials & Systems, Chonbuk National University, Jeonju, Republic of Korea
³Department of Semiconductor and Chemical Engineering, Chonbuk National University, Jeonju, Republic of Korea
*Corresponding author: +82-63-270-2311; nahmks@jbnu.ac.kr

LiCoO₂ is a most popular cathode material in lithium battery industries. But the high cost and toxicity of cobalt have drawn attention to find alternative materials. Manganese of various alternative materials has been highly considered as alternative because it is environmentally friendly and inexpensive. For the lithium ion battery applications in medium and large-scale energy devices, a new active material with structural stability and high capacity is essential. So, in this study, we have synthesized spinel–layered mixed structured composite oxides based on Mn–Ni, with stable structure and high capacity for Li ion battery cathodes. The materials were synthesized and characterized for its structural and electrochemical properties. We used a batch type reactor equipped with a teflon-type impeller at a stirring speed of 150~400rpm for material synthesis. Initially, we synthesized the transition metal precursor using co-precipitation method. We then synthesized the spinel–layered mixed structure by mixing the synthesized precursor with the lithium precursor by calcination. But on battery cycling, after 50cycle, Co undoped sample exhibited very low stability with capacity maximum of approximately 90mAh/g. We also synthesized Co-doped (Co-composition x=0.05, 0.15, 0.25) transition metal precursor using solid state method. Then again by using previous method we synthesized the spinel-layered mixed structure by mixing the synthesized co-doped precursor and lithium precursor by calcination. The transition metal precursor showed MnCO₃ (rhodochrosite, R-3c, JCPDF 44-1472) structure and the final material showed spinel and layered mixed structure which was confirmed with XRD. Electrochemical properties were tested at a current density of 0.2mA/cm² within a potential range of 2.0V~4.9V using a 2032 coin type lithium cell. All samples showed the spinel–layered mixed characteristic charge–discharge curves and Co doped sample synthesized at Co composition x=0.15 showed highest stability with capacity maximum of 220mAh/g.