Synthesis and characterization of spinel-layered mixed cathode materials for Li-ion batteries from Ni-Mn precursor in CSTR reactor at different feeding times

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Although the $LiCoO_2$ cathode dominates the rechargeable lithium battery market, there is a limited availability of cobalt, which has disadvantaged much as high price and toxic. Lithium nickel oxide is isostructural with lithium cobalt oxide but has not been pursued in the pure state as a battery cathode for a variety of reasons, even though nickel is more readily available than cobalt. The spinel lithium manganese oxide has been extensively developed as alternative cathode material but has very low capacity. So, In this study, we synthesized spinel–layered mixed composite oxide 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. Initially, we used a CSTR equipped with a cross-type impeller at a stirring speed of 800rpm. We synthesized the transition metal precursor using co–precipitation method with different feed time (4h, 8h and 16hr) at a feed rate of 4.167ml/min. We then synthesized the spinel–layered mixed structure by mixing the synthesized precursor with the lithium precursor using calcination. From the structural and morphological characterizations of the transition metal precursor, it was proposed that all the primary particles gathered to form secondary spherical particles. It was also observed that the particle size increased as the feed time increased and, with more increase in feed time the particle showed smooth surface. The transition metal precursor showed $MnCO_3$ (rhodochrosite, R-3c, JCPDF 44-1472) structure and the final material showed spinel and layered mixed structure confirmed with XRD. Electrochemical properties were tested at a current density of $0.2mA/cm^2$ 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 the sample synthesized with more than 16 hour feed time exhibit a maximum capacity of 247mAh/g.