High-Rate Capability and Cyclic Stability of Ni-rich Layered Oxide $LiNi_{0.83}Co_{0.12}Mn_{0.05-x}AlxO_2$ cathodes: Nanofiber vs Nanoparticle Morphology

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Abstract

High energy density Ni-rich layered oxide cathodes $LiNi_{0.83}Co_{0.12}Mn_{0.05-x}Al_xO_2$ (x=0, 0.025, 0.05; NMC, NMCA, and NCA, respectively) are fabricated in two different microstructural forms: (i) nanoparticles (NP) and (ii) nanofibers (NF), to evaluate the morphology and compositional effect on the electrochemical properties using same precursors, with the latter fabricated by electrospinning process. Although all the cathodes exhibit a similar crystal structure as confirmed by X-ray diffraction and Raman spectroscopy, contrasting difference is observed in their electrochemical properties. XRD and XPS analyses indicate a higher amount of cationic disorder for the NP cathodes compared to their NF counterparts. Nanofibrous Ni-rich layered oxide cathodes exhibit higher discharge capacities at all C-rates in comparison to NP cathodes. When cycled at 1C-rate for 100 cycles, capacity retention of 81% is observed for NCA-NF, which is superior to all cathodes. Voltage decay as a function of the charge-discharge cycle is found to be low (0.2 mV/cycle) for nanofibrous cathodes compared to 1.5 mV/cycle for NP cathodes. The good rate capability and cyclic stability of nanofibrous Ni-rich layered oxide cathodes are attributed to a shorter pathway of Li^+ diffusion and a large proportion of the active surface area.

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