Understanding capacity fading mechanism in Ni-rich layered oxide cathodes

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High energy density of lithium-ion batteries (LIBs) is required for applications such as electric vehicles (EVs) and energy storage systems (ESSs). In this regard, Ni-rich layered oxides ($LiN_{ix}Co_yMn_{1-x-y}O_2$, with x>0.7, Ni-rich NCM) have received lots of attention as cathode materials for Li-ion batteries due to its higher discharge capacity and lower cost than those of conventional $LiCoO_2$. NCM with high Ni-content such as $LiN_{0.8}Co_{0.1}Mn_{0.1}O_2$ (NCM811) has been widely investigated because the specific capacity of NCM is mainly determined by the Ni content. However, Ni-rich NCM suffers from capacity fading, which makes it difficult for using it in the cell. Most studies have focused on improving capacity retention of Ni-rich NCM by the doping, surface coating, synthesis condition optimization and additives in electrolyte. It is even more important to understand the capacity fading mechanism in Ni-rich NCM in order to find the right solution. As factors causing capacity fading, phase transformation of NCM, electrolyte oxidation, instability of Ni^{4+} were suggested. What is the more dominant cause and what the causes are related to should be researched in detail.

In this poster, we discuss the capacity fading mechanism in NCM811 with respect to the stability of the surface, the loss of active elements, and surface reaction with the electrolyte at high voltage conditions even for long time by using several techniques including XPS and Impedance spectroscopy, etc. We try to make correlation the capacity fading with those experimental data and then suggest appropriate approaches to improve electrochemical performance in Ni-rich NCM.