

PROTECTION OF 5V CATHODE MATERIALS WITH ATOMIC LAYER DEPOSITION OF DIFFERENT OXIDES

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In order to increase the energy density of lithium-ion batteries, a promising solution is to use positive materials with high potential (4.5 to 5.2 V vs Li + / Li) [1]. However, this operating potential is largely above the stability range of conventional electrolytes. Degradation to the surface of the positive material causes a decrease in coulombic efficiency and a rapid drop in the amount of stored energy. One of the strategies proposed by the scientific community is to deposit a protective nano-layer of oxide to limit interfacial reactivity [2].

High voltage spinel $\text{LiNi}_{1/2}\text{Mn}_{3/2}\text{O}_4$ shows good electrochemical properties but suffers from capacity loss induced by transition metal dissolution, and efficiency loss induced by electrolyte oxidation. In order to exacerbate these phenomena, different ways to charge the material were used. Figure 1 shows a faster degradation with a 1 hour 5V holding at the end of charge. The loss of capacity is speeded up after few cycles, compared to usual cycling.

In order to mitigate this loss of capacity, the electrode surface was covered with ultrathin layer of different oxides, such as Al_2O_3 , deposited by atomic layer deposition (ALD). Thickness of such oxides is a key factor. 5, 10, 20 & 50 ALD cycles were used for reaching different thickness. Coverage, physical properties and chemical composition of each of these layers were investigated by means of XPS, EIS, and TEM. The role of different oxides on LNMO's electrodes is discussed according to their chemical, physical and electrochemical properties.

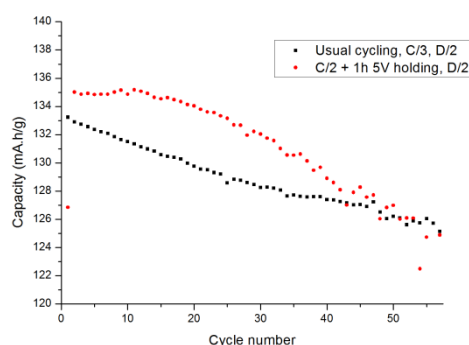


Figure 1 Capacity of LNMO spinel with different cycling parameters

[1] Nanotechnology for Sustainable Energy, Hu, Y., et al., ACS Symposium Series, American Chemical Society, Washington, DC, 2013

[2] Ultrathin Coatings on Nano-LiCoO₂ for Li-Ion Vehicular Applications, Isaac D. Scott, Yoon Seok Jung, Nano Lett. 2011, 11 (2), pp 414–418