Long term cycling performance of high-capacity lithium-ion full cells with LiDFOB- and LiBOB-electrolyte additives

Yan Li[1,2], Ye Zhu[2], Martin Bettge[2], James C.M. Li[1]
Daniel P. Abraham[2]
[1]Materials Science Program, University of Rochester, Rochester, NY 14627
[2]Chemical Science and Engineering Division, Argonne National Laboratory, Argonne, IL 60439

Lithium– and manganese– rich transition metal layered oxides (LMR-NMC), e.g. $Li_{1.2}Ni_{0.15}Mn_{0.55}Co_{0.1}O_2$, have been widely investigated due to their low cost, high energy density and good thermal stability.[1] Full cells containing LMR-NMC-based positive electrodes and graphite-based negative electrodes are promising candidates for transportation applications. However, our research reveals that this couple shows severe capacity fade, which mainly results from Li trapping in the solid electrolyte interphase (SEI) of the negative graphite electrode, and large impedance rise and voltage fade, which mainly comes from the degradation of oxide and carbon constituents contained in the positive electrode.[2]

Introducing a protective coating on the positive electrode has been shown to be an effective way to improve cycling performance of full cells.[3] Adding small amounts of inorganic additives into the electrolyte is another effective method to improve performance of lithium-ion cells. These additives can decompose and form passivation layers on either cathode or anode and also increase thermal stability of the electrode, especially for LiBOB and LiDFOB.[4, 5]

Our previous work [5]has already shown that LiDFOB can be used as a bi-functional electrolyte additive in $Li_{1.2}Ni_{0.15}Mn_{0.55}Co_{0.1}O_2$//graphite cells to protect both positive and negative electrodes; the additive improves performance of full cells cycled 200 times up to 4.7V vs. Li/Li^+. In this presentation we will discuss the long-term (up to 1000 cycles) cycling performance of cells with 2 wt.% LiDFOB or 1 wt.% LiBOB as additives in the Gen 2 electrolyte [1.2 M $LiPF_6$ +EC: EMC (3:7 by wt)]. Electrochemistry data from cells containing a Li-Sn reference electrode will be discussed. Surface analysis of the positive and negative electrodes, including data from X-ray photoelectron spectroscopy (XPS) and secondary ion mass spectrometry (SIMS) will be presented to explain possible mechanisms for the protective functions of each electrolyte additives.

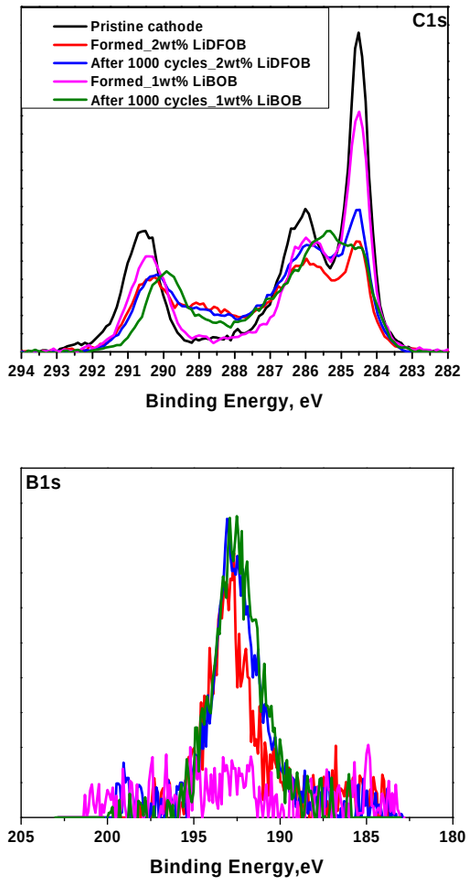

Figure 1. XPS spectra from the fresh positive electrode and harvested positive electrodes from 2wt% LiDFOB-bearing cells and 1wt% LiBOB-bearing cells after formation cycles and after 1000 cycles.

References

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