Post mortem investigation of ageing in NMC based cells cycled at different temperatures

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In order to increase the competiveness of electric vehicles (EVs) against conventional combustion engine vehicles the cost of lithium ion batteries (LIBs) needs to be reduced, as this cost is significant in EVs. Degradation of the batteries lead to further costs as the LIBs have to be exchanged after a few years of usage, which can be mitigated by cells with increased lifetime. Battery ageing during cycling take place by several kinds of unwanted side reactions, leading to reduced capacity. Examples include continuous growth of passivating surface films on the electrodes increasing the impedance, dissolution of manganese ions from the positive electrode, structural transformations, lithium plating on the negative electrode, exfoliation of graphite and loss of contact between electrode particles. These side reactions are known to be influenced by cycling conditions such as temperature, cycling rate and the utilized state-of-charge (SOC) range. To minimize the degradation as much as possible, the influence of these conditions on the battery cycle life needs to be understood in a better detail.

In this study, $LiNi_{0.33}Mn_{0.33}Co_{0.33}O_2$ (NMC), which is an interesting commercial cathode material, was characterized. As this material is currently available on the market, it is of importance to perform further characterization to achieve higher lifetime. NMC has several advantages *e.g.* high energy density, lower cobalt content than $LiCoO_2$ [2] and good rate capability. In order to decrease the influence of cross-talk between the electrodes a negative electrode operating on a potential within the electrochemical stability window of the electrolyte should be used, *i.e.* no solid electrolyte interphase (SEI) formation should take place. A possible candidate material is lithium titanate ($Li_4Ti_5O_{12}$, LTO), which is also known to have minimal volume expansion during cycling[1], making it a very robust electrode material allowing extended cycling with only minor degradation.

Here lab-built NMC-LTO cells with an electrolyte based on $LiPF_6$ salt dissolved in organic carbonates were electrochemically characterized by galvanostatic cycling at different temperatures. Post mortem analysis of the electrodes was thereafter performed by X-ray photoelectron spectroscopy (XPS) to investigate changes in surface composition and thickness changes in the SEI.

References:

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