INFLUENCE OF DOPANTS ON THE STABILISATION OF HIGH ENERGY NCM $Li_x(Ni_aCo_bMn_c)O_2$

Juliette Billaud, Sébastien Sallard, Petr Novák, Claire Villevieille
Paul Scherrer Institut, Electrochemistry Laboratory, CH-5232, Villigen PSI, Switzerland

juliette.billaud@psi.ch

Lithium-ion batteries are nowadays the most advanced devices for portable energy storage and they started to enter the electric vehicle market. Current materials used on the positive electrode side have energy densities below 600 Wh kg^{-1} ($LiCoO_2$ and $LiFePO_4$), which represents one of main limitations in the improvement of their performance.
Amongst the compounds operating at high potential, a family of layered materials with the chemical formula $Li_xNi_aCo_bMn_cO_2$ (denoted HE-NCM) is the center of intensive investigations since the last decade.[1] They exhibit a specific charge of up to 250 mAh g^{-1}, corresponding to an energy density of *ca.* 900 Wh kg^{-1}.
However, ageing of HE-NCM materials induces a fading of the specific charge and more challenging a depletion of the average discharge potential. This is due to the evolution of their structure upon cycling attributed to i) leaching of the transition metals at high voltage and ii) mobility of cations between slabs and interslabs.

In order to improve the performance of HE-NCM materials, we have developed various doping strategies in order to stabilise the potential upon cycling without compromising the specific charge. Various dopants (shown as Z in Figure 1) have been studied. The overall crystallographic structure is kept, although some minor changes are observed, as will be discussed in the presentation. Moreover, a mitigation of the potential dropping has been observed (see Figure 1.b): the average potential is not only higher but also fades less upon cycling. Besides the specific charge remains above 200 mAh g^{-1} (see Figure 1.a).

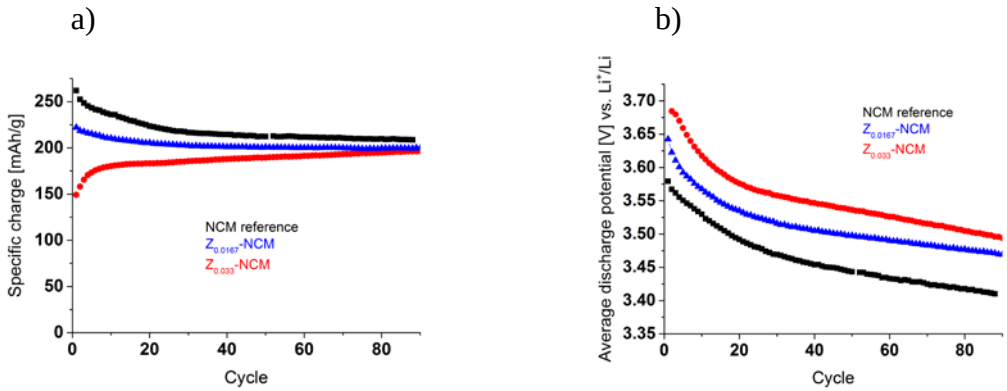

Figure 1.a) Evolution of the specific charge as a function of cycle of standard HE-NCM and Z-doped NCM; b) Evolution of the average discharge potential as a function of the cycle number of standard HE-NCM and doped NCM

References:

[1] S.-H. Kang, P. Kempgens, S. Greenbaum, A. J. Kropf, K. Amine, and M. M. Thackeray, *J. Mater. Chem.*, **17**, 20 (2007) 2069.