Morphological changes of Li-rich Ni, Mn, Co oxides upon cycling using X-ray ptychographic tomography

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Li-rich Ni, Co and Mn oxides are at the heart of intensive investigations for use as cathodes in lithium-ion batteries. They exhibit a specific charge of up to 250 mAh g^{-1}, at high potential vs. Li^+/Li. These materials however suffer from a smooth but constant decrease of their specific charge upon cycling, as shown in Figure 1a. The evolution of the galvanostatic profiles at the 1st and the 100th cycles (Figure 1b) confirms this loss of specific charge (red arrow 1). It also evidences a severe ageing of the material with a drift of the average discharge potential towards lower values (red arrow 2). 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. It has also been proved that morphological changes occurring in electrode materials upon cycling strongly influence battery performance, leading in particular to failure mechanisms. [1]

In this poster, we will correlate the degradation of the electrochemical performance occurring after long term cycling with morphological changes (ie change in porosity, chemical gradient, etc.) by ptychographic tomography (see Figure 1c). Ptychographic nanotomography at the cSAXS beamline (Swiss Light Source, PSI) provides unique high-resolution 3D electron density maps of the probed sample at nanometer scale. This is required to characterise the structural integrity and determine morphological changes that can affect the battery performance. [2,3] Thanks to this incredible resolution and the 3D reconstruction of the morphology of aged particles we elucidate the ageing mechanisms of the promising Li-rich NMC materials as cathodes for Li-ion batteries.

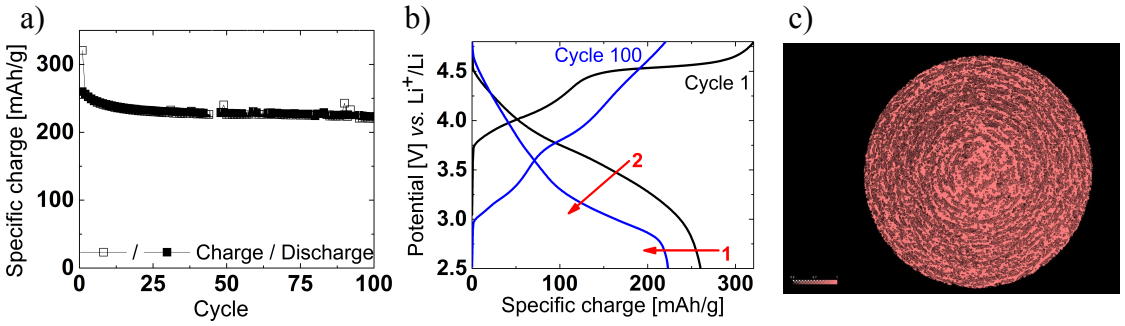

Figure 1 a) Evolution of the specific charge as a function of cycle, b) Evolution of the specific charge as a function of the potential, c) Typical reconstructed slice of a pristine Li-rich NCM imaged by ptychographic tomography at cSAXS.

References:

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