Abstract for oral presentation

Multi-scale Correlative Tomography of Li-Ion Battery Cathode Morphology

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To improve the overall performance of Li-ion batteries, a deeper understanding of their microstructure and electrochemical transport mechanisms has to be gained [1]. In this regard, X-ray tomography (Xt) is commonly used to acquire and analyze 3D reconstructions of battery electrodes. A metal-oxide battery electrode consists of at least three phases: active material, carbon binder domain (CBD), and electrolyte filled pore space. To investigate an X-ray dataset of such an electrode, it has to be segmented into these phases. Hereby, various challenges arise: i) Segmentation has large impact on both volume and surface area of the reconstructed phases, which in turn affects the calculation of transport parameters. ii) High mass attenuation coefficients of the metal-oxide compared to the CBD results in a poor contrast of the CBD. iii) Both phases show structures in the micro- and nanometer range, which cannot be accounted for by using just one tomography technique [2]. Therefore it is very difficult to image all phases in a representative manner, so that the common tomographic approach is to image either the active material or the CBD. In this study we use a correlative approach consisting of Xt and focused ion-beam tomography (FIB-SEMt) to address all of the problems above. Both Xt and FIB-SEMt have been performed on the same lithium manganese dioxide (LMO) cathode at the exact same spot. This allows a profound validation of Xt segmentation and an extraction of both the LMO and CBD structure on a scale of several hundred microns in Xt datasets, which has not been reported before.

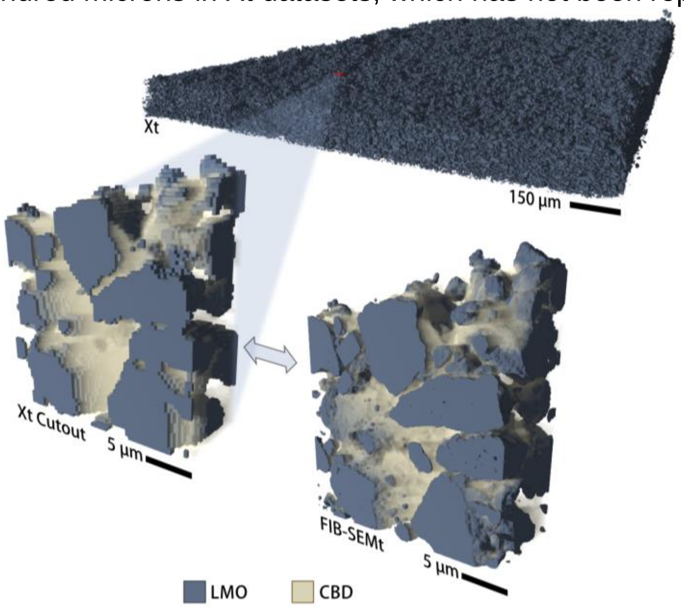

Figure 1: 3D Representation of both the Xt and FIB-SEMt datasets. Top: Xt reconstruction of the investigated LMO cathode. Bottom Left: Cutout of the Xt reconstruction from above. Bottom right: FIB-SEMt reconstruction acquired from the same sample at the same spot.

[1] F. Tariq, et al., J. Power Sources, 248 (2014), pp 1014–1020.
[2] D.E. Stephenson, et al., J. Electrochem. Soc., 158 (2011), pp 781–789.