In-situ Bragg Coherent Diffractive Imaging of Single Anode and Cathode Particles

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Lithium Titanate (LTO) is a potential anode material and $LiNi_xMn_yCo_{1-x-y}O_2$ (NMC) is a widely used cathode material. This talk reports how the experimental challenges were overcome to make in-situ Bragg Coherent Diffractive Imaging (BCDI) experiments on these materials at the Advanced Photon Source synchrotron facility. Coin cells with small kapton windows were prepared and run through charge/discharge cycles at conventional charging rates lating several hours [1]. Careful selection of multiple particles using an automated alignment algorithm allowed these to be tracked during the cycles. Occasionally one or more particles was found to not respond to the applied current, so was concluded to be damage or located in a blind part of the coin cell. LTO undergoes a phase transformation between $Li_4Ti_5O_{12}$ and $Li_7Ti_5O_{12}$ states, both within the same cubic crystal lattice. We present the results of BCDI and in situ X-ray diffraction (XRD) experiments [2] to examine the lithium insertion-induced materials phase transformation within a single LTO particle. BCDI analysis of the (111) Bragg peak shows the two-phase transformation manifesting as a distinct image phase modulation within a single LTO nanoparticle occurring in the middle of the discharge region then subsiding toward the end of the discharge cycle. More recent BCDI experiments on NMC were used to address the question of voltage decay and degradation in Mn-based cathodes, y~1 [3], and in high Ni content materials, x=0.8, during cycling [4].

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