Revealing Spatio-dynamics of lithium battery by synchrotron-based x-ray microscopy

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The rate capability and lifetime of Li-ion battery are fundamentally governed by insertion rate and uniformity of ion insertion reaction at the solid/liquid interface of individual battery particles. The conventional current-voltage measurement of Li-ion batteries, however, shows a limit in untangling complexity of electrochemical reactions because the electrodes containing an ensemble of batteries are highly heterogeneous. In this research, we develop a liquid X-ray microscopy platform that precisely tracks the nanoscale evolution of the Li\textsuperscript{+} composition and insertion rate in Li\textsubscript{x}FePO\textsubscript{4} primary particles, with high spatial (\textasciitilde 50 nm) and temporal (\textasciitilde 30 s) resolution. By tracking the same particles under multiple cycling conditions, we show that nanoscale spatial variations in rate and in composition control the lithiation pathway at the sub-particle length scale, beyond the well-documented phase separation and solid solution pathways at the crystallographic level. We will further discuss the potential applications of our analysis platform beyond Li-ion batteries.

References: