

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⁺ composition and insertion rate in Li_xFePO₄ primary particles, with high spatial (~ 50 nm) and temporal (~ 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:

- [1] J. Lim et. al., *Science*, 353, 6299. (2016) pp 566-571