Mesoscale Phase Distribution in Li-ion Battery Electrode Materials

Scientific Achievement

We have used TXM-XANES to produce chemical maps at 30 nm resolution of the distribution of species involved in the delithiation of micron-sized $LiFePO_4$ plate-like crystals.

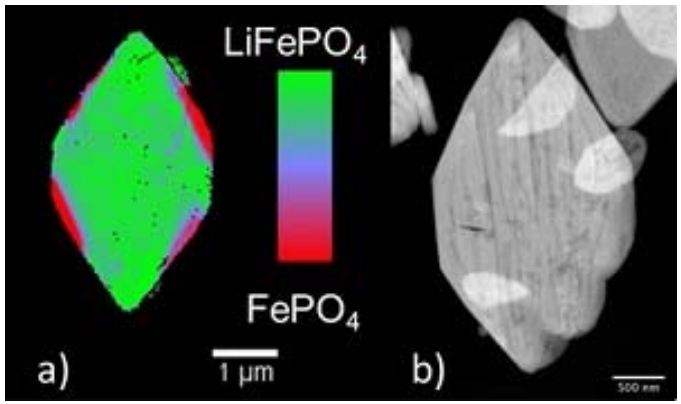
Significance and Impact

The high spatial and chemical resolution of TXM-XANES can be used to build a complete picture of the fundamental mechanisms of diffusion and phase transformation at the single particle level.

Research Details

–Chemical maps of partially delithiated $LiFePO_4$ microplates were obtained at 30 nm resolution using TXM-XANES. These maps were compared to morphological information collected by STEM, which revealed the existence of cracking during delithiation due to strain buildup.

–The results revealed the interplay between crystal microstructure and redox reactions at the mesoscale. The specific mechanism was found to be controlled by kinetic limitations, as well as thermodynamic effects.



a) Chemical phase map obtained by linear combination fitting of XANES data at each pixel acquired with FF TXM at Beam Line 6-2 at SSRL, and b) STEM image of a particle in a sample with nominal composition of $Li_{0.74}FePO_4$. Figure adapted from Boesenberg et al. 2013

U. Boesenberg, F. Meirer, Y. Liu, A. K. Shukla, R. Dell'Anna, T. Tyliszczak, G. Chen, J. C. Andrews, T. J. Richardson, R. M. Kostecki, J. Cabana, " Mesoscale Phase Distribution in Single Particles of $LiFePO_4$ following Lithium Deintercalation", Chem. Mater. 25, 1664 (2013) - DOI: 10.1021/cm400106k

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