Probing Structural Dynamics with High Spatial and Temporal Resolution

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Purpose

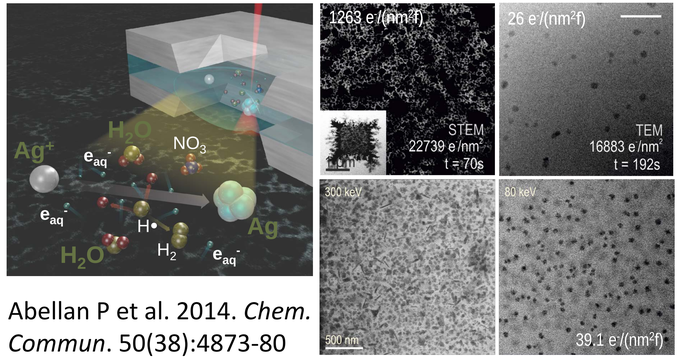
- Develop understanding of structural dynamics occurring down to the ns timescale
- Make a unique aberration-corrected Dynamic TEM (DTEM), where a photoemission source enables time-resolved images to be obtained at/near atomic resolution

Key Successes

- Developed method to evaluate stability and degradation in battery electrolytes
- Identified beam-sample interactions important to quantification for a range of imaging conditions
- Modified, installed electron gun.

Research Accomplishments

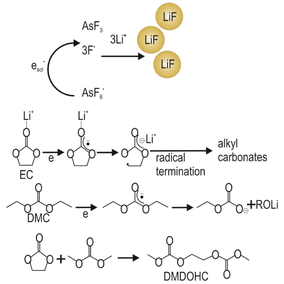
Understanding the reaction with the liquid

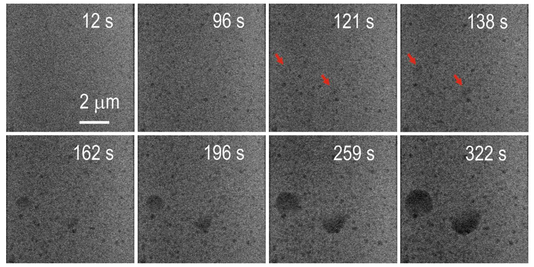


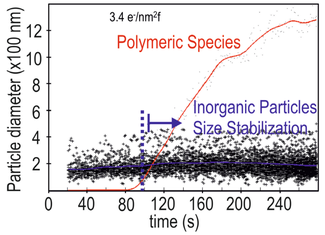
Abellan P et al. 2014. *Chem. Commun*. 50(38):4873-80

Quantitative information can be obtained in the DTEM once the effect of the electron beam is understood. Beam-sample interactions have been identified for a range of experimental conditions used for imaging.

Degradation mechanisms in electrolyte solutions



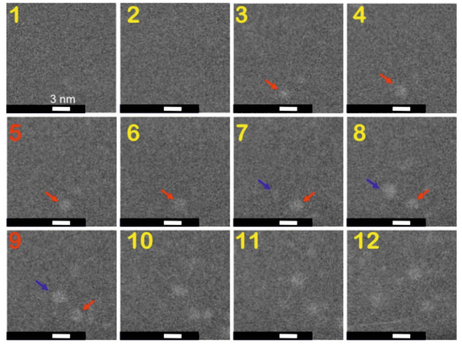


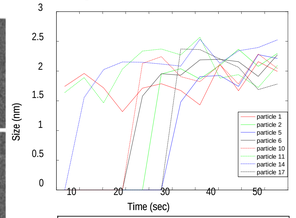


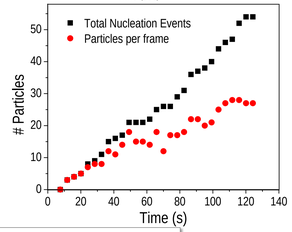
DTEM provides better kinetics to directly monitor dynamic processes during Li-ion battery operation with enough spatial resolution to resolve active particles. We developed a method to evaluate stability and degradation in battery electrolytes.

Abellan P et al. 2014. *Nano Letters* 14(3): 1293-99

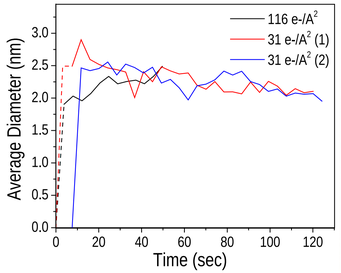
Growth of precisely controlled Pd nanoparticles





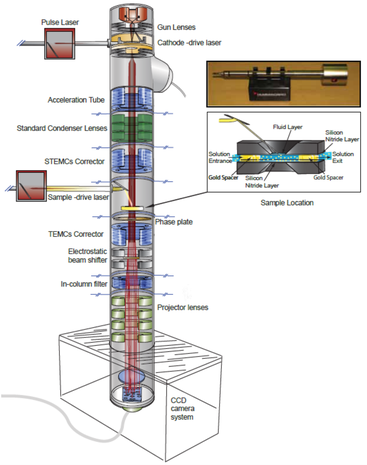


Abellan P et al. *Submitted.*



DTEM helps control electron dose in an in-situ liquid stage. Correlated STEM-SAXS investigation has proven that radical reduction in the liquid stage is equivalent to chemical reduction for a range of electron doses (see Project 1.6).

Progress with the DTEM



Next Steps

- Develop DOE-BES proposal
- First pulses ongoing
- DTEM fully operational October 2014
- Apply in-situ methods in the DTEM.