Atomic-scale characterization of electrode materials by STEM

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Periodic potentials somehow can solve problems to the extent of boundary conditions, but not likely to reveal large scale structural relaxations and reconstructions, sometime in the worst case, the chemistry of materials would experience a great perturbation. Simulations is far below the capability of pursuing exact answers especially for dynamic processes, since energy is not everything. With the help of angular-bright-field (ABF) imaging technique in a scanning transmission electron microscope (STEM), not only heavy elements but also light atoms with limited atomic scattering cross-sections can be observed. Now, it is the time to revisit the atomic structures under electrochemistry to precisely locate individual atoms, of course deviated from periodic "lattice" site by 10 pm, 20 pm or even as large as 40 pm because of symmetry breaking; and to see how these changes have granted materials extraordinary properties.

A JEM-ARM200F STEM operated at 200 kV and equipped with double aberration-correctors for both probe-forming and imaging lenses was used to perform HAADF and ABF imaging. Here we will present our recent efforts on revealing the atomic-scale structure of selected electrode materials with different charge and/or discharge state, e.g., the lattice distortion, phase interface structure, transition metal migration, surface reconstruction with (partial) intercalation and de-intercalation, etc. Future prospect on the relationship between atomic-level structure evolution and microscopic reaction mechanisms of electrode materials for rechargeable batteries is envisaged.