Topological Defect Dynamics in Operando Battery Nanoparticles

Scientific Achievement

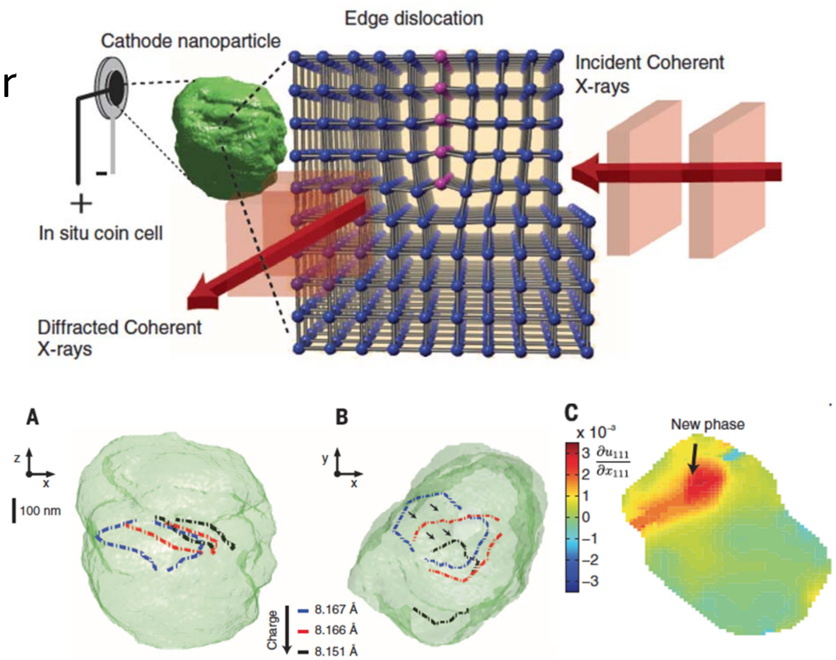
Three-dimensional imaging of dislocation dynamics ir individual battery cathode nanoparticles at high voltage under operando conditions.

Significance and Impact

Operando Bragg coherent diffractive imaging (BCDI) was used to image the dislocation motion in a high voltage cathode material and reveal the key mechanical property that possibly enables high voltage operation in intercalation compounds.

Research Details

- Operando dislocation imaging opens an avenue for facilitating rational “defect engineering” of energy materials.
- We observed the onset of the phase transformation and observed the dislocation act as a nucleation point, and showed how the phase expands into the particle.
- Edge dislocations are mobile in response to charge transport, and the 3D dislocation displacement field serves as a local probe of elastic properties.



Coherent X-rays are incident on a cathode nanoparticle (green) obtaining an edge dislocation (top row) and the three dimensional edge dislocation line evolution due to charging of $LiNi_{1.5}Mn_{0.5}O_4$ to 5V (bottom row) . (A) Evolution of the dislocation line at three different charge states. (B) The same evolution as in (A) for a different view. (C) The strain field at a cross section of the particle.

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