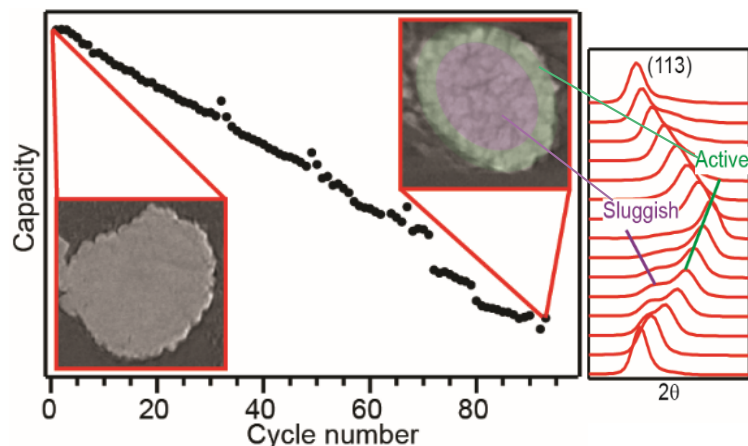


The Microstructural Origin Of Battery Capacity Fading



Scientific Achievement

Operando X-ray diffraction studies reveal heterogeneous reaction kinetics caused by intergranular cracking of secondary electrode particles as the dominant cause for the long-term capacity fading of $\text{LiNi}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$ (NCA).

Significance and Impact

The first demonstration of how mechanical changes (cracking) in battery electrode particles affects the energy storage reaction. This mechanism for capacity fade extends to many battery systems.

Research Details

- Two NCA populations with different reaction kinetics are identified following >3 months cycling. The “active” population shows no capacity loss, while the other “sluggish” population shows slower reactivity and quantitatively explains the capacity loss.
- The sluggish reactivity is caused by intergranular cracking, induced by repeated volume expansion and contraction as the electrode discharges and charges. After cracking, transport to subsurface particles is retarded

Operando X-ray diffraction reveals two populations of NCA (“sluggish” & “active”) with different reaction kinetics. Intergranular cracking compromises the ionic and electrical conductivity of grains inside a secondary particle and leads to the “active” and the “sluggish” NCA grains at the surface and core of a secondary particle, respectively.

Reference

H. Liu, M. Wolf, K. Karki, Y.S. Yu, E. A. Stach, J. Cabana, K.W. Chapman, P.J. Chupas, *Nano Lett.* **17**, 3452, 2017

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