Resolving Lithium Deposition Processes in Li-ion Batteries

Poseidon 510 combines quantitative imaging analysis and detailed electrochemical measurements

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The Microscopy Group at Oak Ridge National Labs in Tennessee have used the latest advances in liquid cell fabrication and in-situ TEM to study Li deposition and SEI formation in a standard battery electrolyte. Led by Raymond R. Unocic, they used the Poseidon 510 system along with a C_s aberration corrected FEI Titan operating at 300 kV. The Poseidon 510 enables the simultaneous use of quantitative STEM imaging and quantitative electrochemical measurements, allowing the team to study Li electrodeposition and SEI formation in great detail

Key Objectives

- Study nanoscale electrochemical reactions in a Li-ion battery using in-situ liquid cell TEM
- Investigate the mechanism of SEI formation
- Track Li nucleation and growth mechanisms from standard organic battery electrolyte

Challenge

- Lithium is an ideal metal for use in lithium-ion battery anodes
- However, formation of an unstable SEI layer and dendrites cause short-circuit and reduce battery cycle life
- Plagued development of Li-ion battery technology for decades
- Requires an understanding of nanoscale mechanism of Li deposition

Solution

- The Microscopy group at ORNL used the Poseidon 510 electrochemical holder
- Combined with a Gamry reference 600 potentiostat and C_s aberration corrected FEI Titan operating at 300 kV
- Combined detailed electrochemical measurements and image analysis
- Streamlined the study of Li electrodeposition and SEI formation
- Allowed the use of STEM imaging to determine density changes in deposits

Results

- Determined that the SEI layer was twice as dense as the electrolyte
- Demonstrated that image intensity could help estimate mass and thickness of Li deposits
- Poseidon 510 holder successfully combined quantitative electrochemical measurements with quantitative imaging in liquids.
- Demonstrates that in-situ ec-S/TEM is a potent method for studying electrochemical reactions, a vital prerequisite for future advancement of Li-ion batteries.