Single Particle Electrochemical PerformanceTesting System

SPEC Series

Introduction

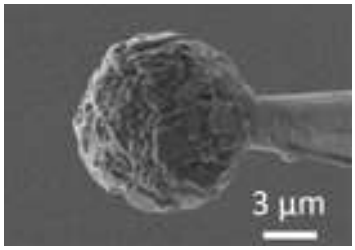
- The study of intrinsic electrochemical properties of materials requires eliminating the influence of fabrication processes, which can be achieved from a single-particle perspective.
- Characterizing particle-level electrochemistry serves the following three purposes:

Battery Modeling

Battery Failure Analysis

High-Throughput Screening of Battery Materials

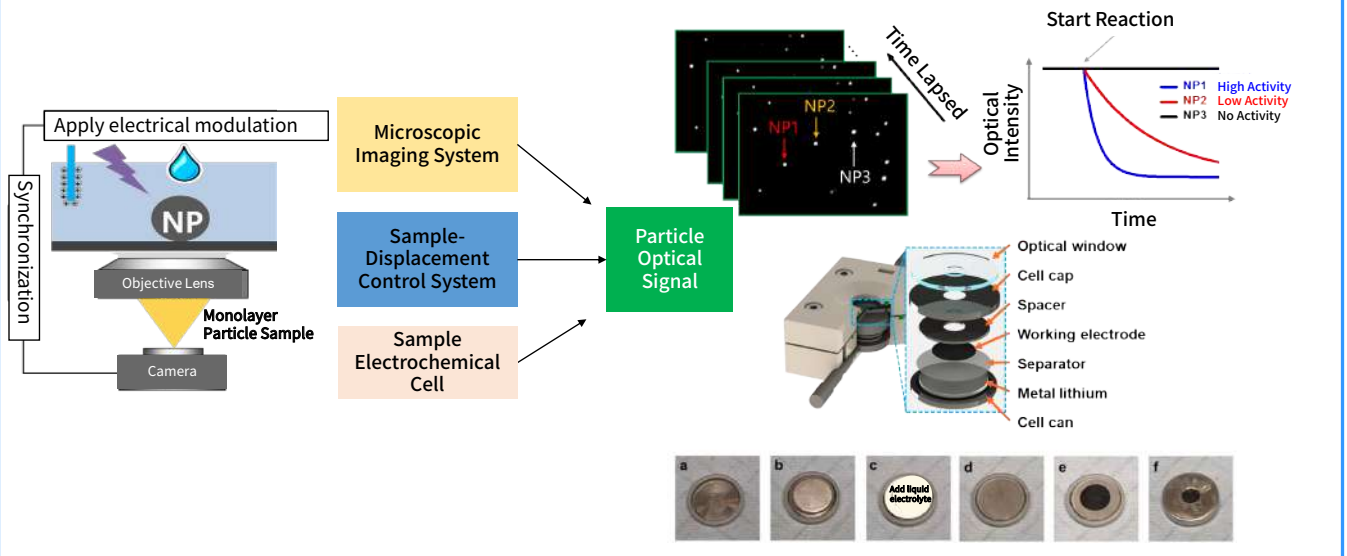
- Limitations of Traditional Single-Particle Methods:
  - Low throughput – only a few particles can be measured at a time.
  - Poor statistical relevance – the electrochemical behavior of a single isolated particle is not representative of the bulk material.



Innovative Solution

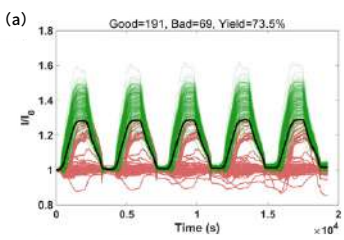
Optical imaging of monolayer-particle coin cells tracks real-time signals from multiple particles for particle-level electrochemical evaluation.

Schematic of the Instrument and Operating Principle

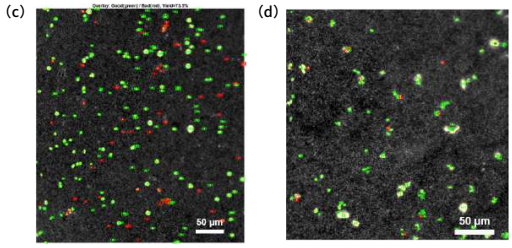


Application Cases

Single-Particle Level Activity Distribution



Statistical Results of Single-Particle Electrochemical Activity

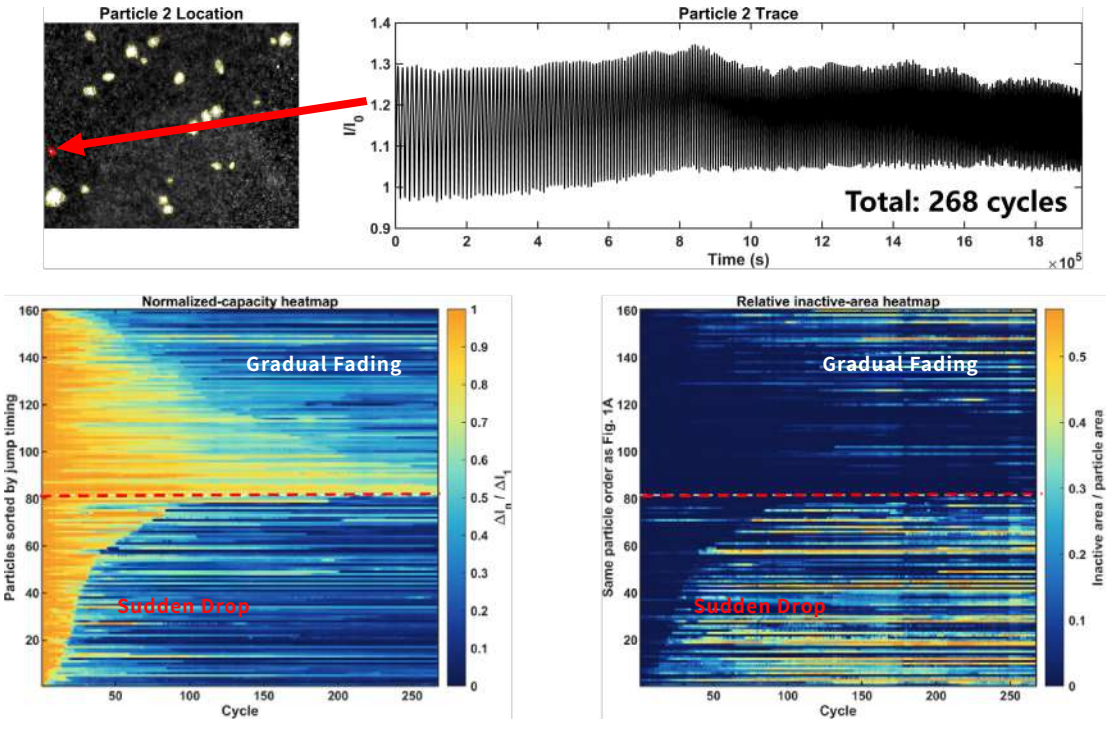


Ni80 LCO

Spatial Distribution of Single-Particle Electrochemical Activity

- √ Coin cells with monolayer particle electrodes are assembled.
- √ During cycling, optical-intensity curves from multiple particles are compared with the average curve to define the active-particle yield.

Ni80 Particle Level Long-Cycle Capacity-Fade Analysis

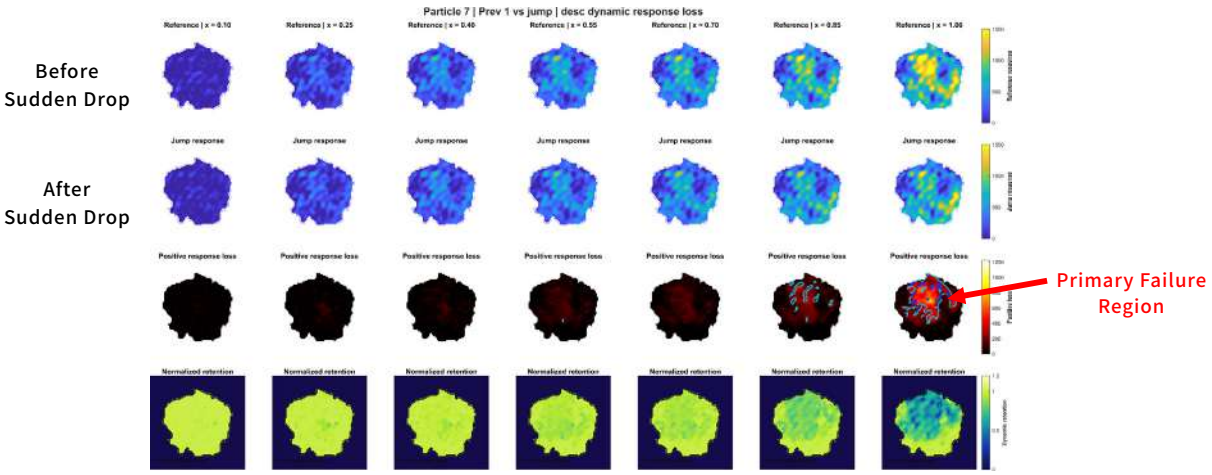


Gradual Fading vs. Sudden Drop

- √ The optical-intensity variation of individual particles decreases markedly with battery cycling, which is correlated with capacity fading.
- √ Batch analysis of optical signals from multiple particles can support cell failure analysis.

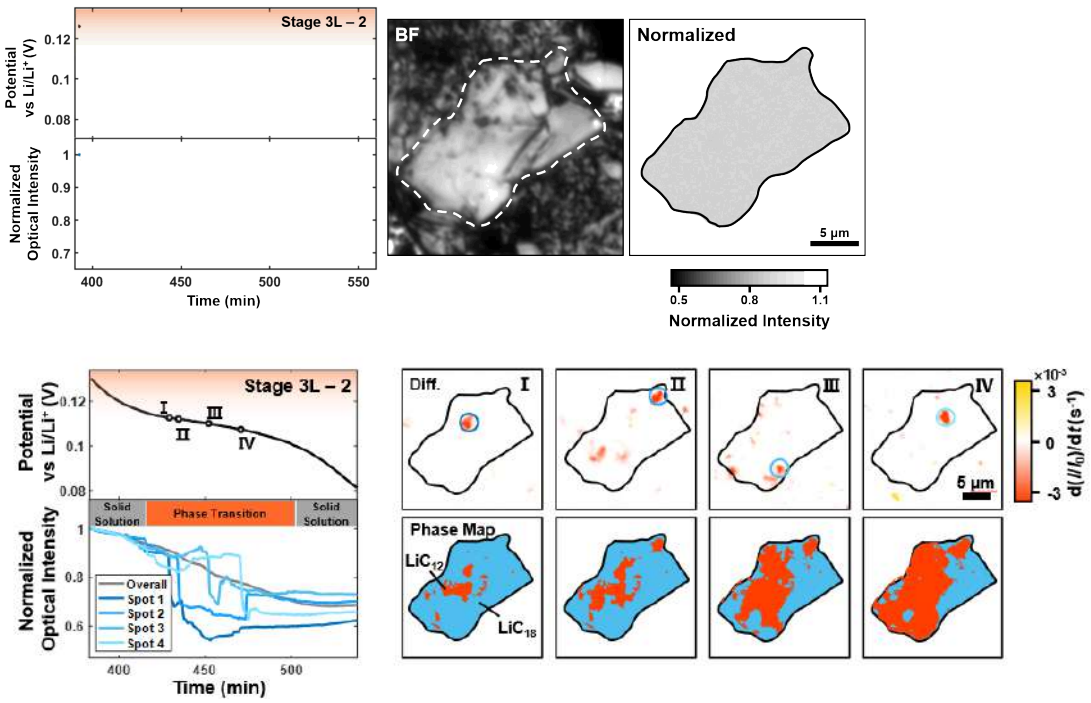
Single particles also show sudden capacity drops.

Ni80 Particle Level Long-Cycle Capacity-Fade Analysis



Spatial heterogeneity in capacity fading and sudden drops.

Graphite Phase-Transition Mechanism Study



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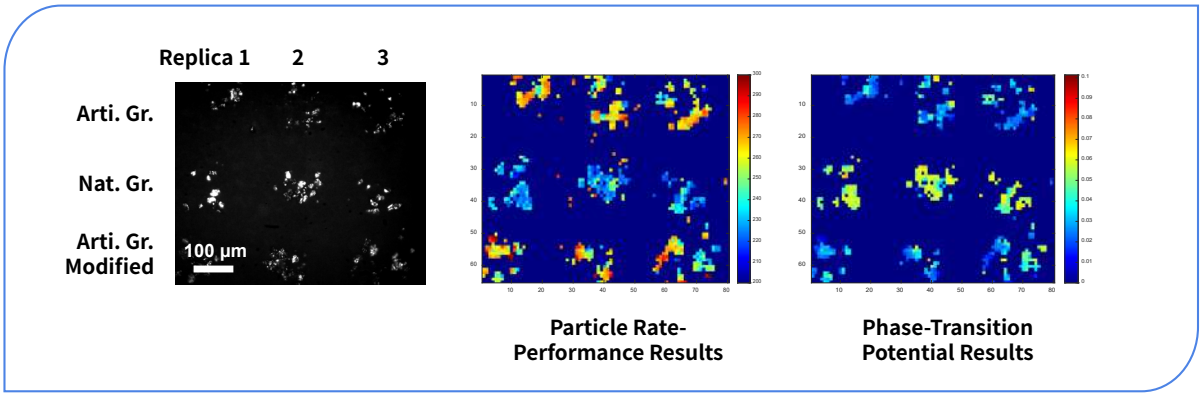
☑ Reveled a “Stochastic nucleation- Confined propagation” mode during graphite lithiation.

☑ Spatially resolved mechanism.

High-Throughput Material Screening



Using multi-sample particle spotting, the electrochemical activity of different particles can be observed and compared simultaneously.

Key Specifications

Model	SPECT1000
Single-particle resolution	> 375 nm
Image acquisition frame rate	< 1 Hz
Field of view	312×250 μm
Magnification	40×
Light-source wavelength	400-700 nm

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