Novel SOC and SOH Estimation Through Sensor Technology

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Southwest Research Institute®

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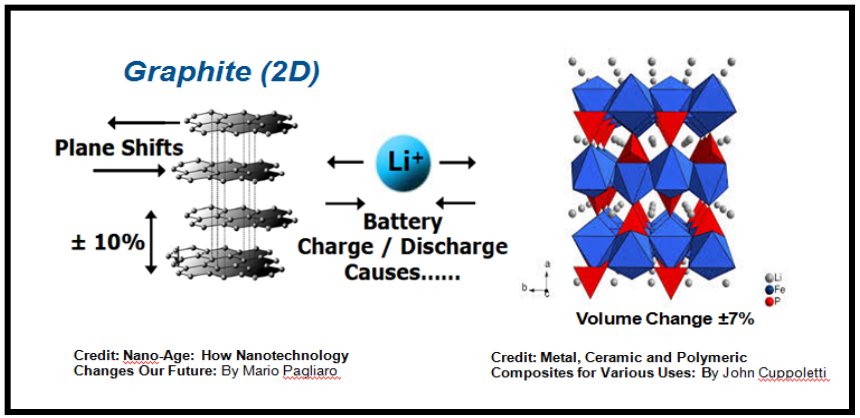
Project Topic: Strain-Based Lithium-Ion Batteries SOC/SOH Measurement

Technology Description

- Strain measurement is based on battery volume changes caused by electrode intercalation/de-intercalation process
- The correlation between strain versus SOC/SOH is developed using cell-modeling and strain-gauge-based correlations coupled with control algorithms



Differentiation

- More accurate and direct feedback of SOC/SOH to BMS
- A robust measurement of battery internal states
- Scalability to any battery pack size and configuration
- Low-cost and low-processing-power solution for SOC/SOH estimation in a vehicle controller

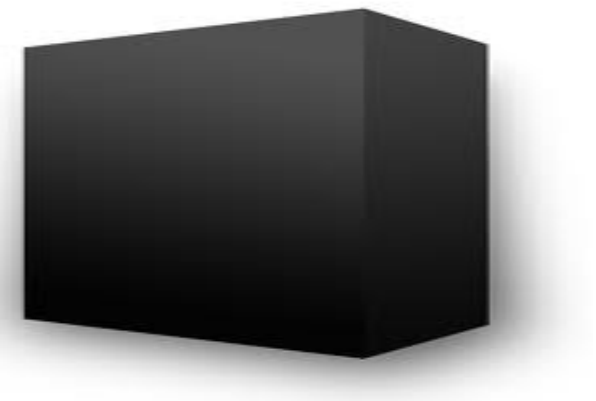
Benefits to the System

1. Simplicity and robustness
2. Accuracy with lost cost implementation

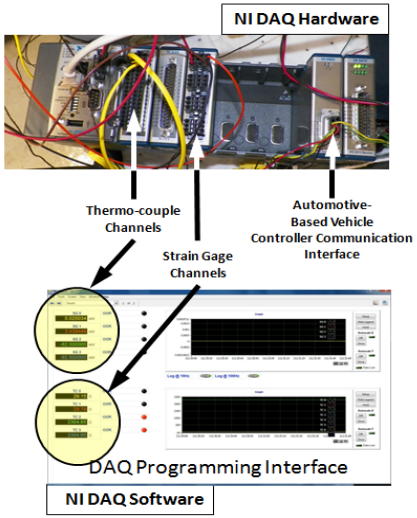
Metrics	State-of-Art	SwRI
SOC accuracy	~5%	2% over life
SOH accuracy	N/A	0.00125%/custom cycle

Lithium-Ion Cells in One of the SwRI's Custom Testing Fixture & Environment

In order to evaluate the impact of cell temperature on SwRI's strain-based SOC and SOH approach, Customization of fixtures and lab equipment have been built to allow cells/modules to be tested simultaneously for various cycling conditions to validate **that strain can be tracked to a certain level of accuracy regardless of charge and discharge currents, cycling paths, or cell history**



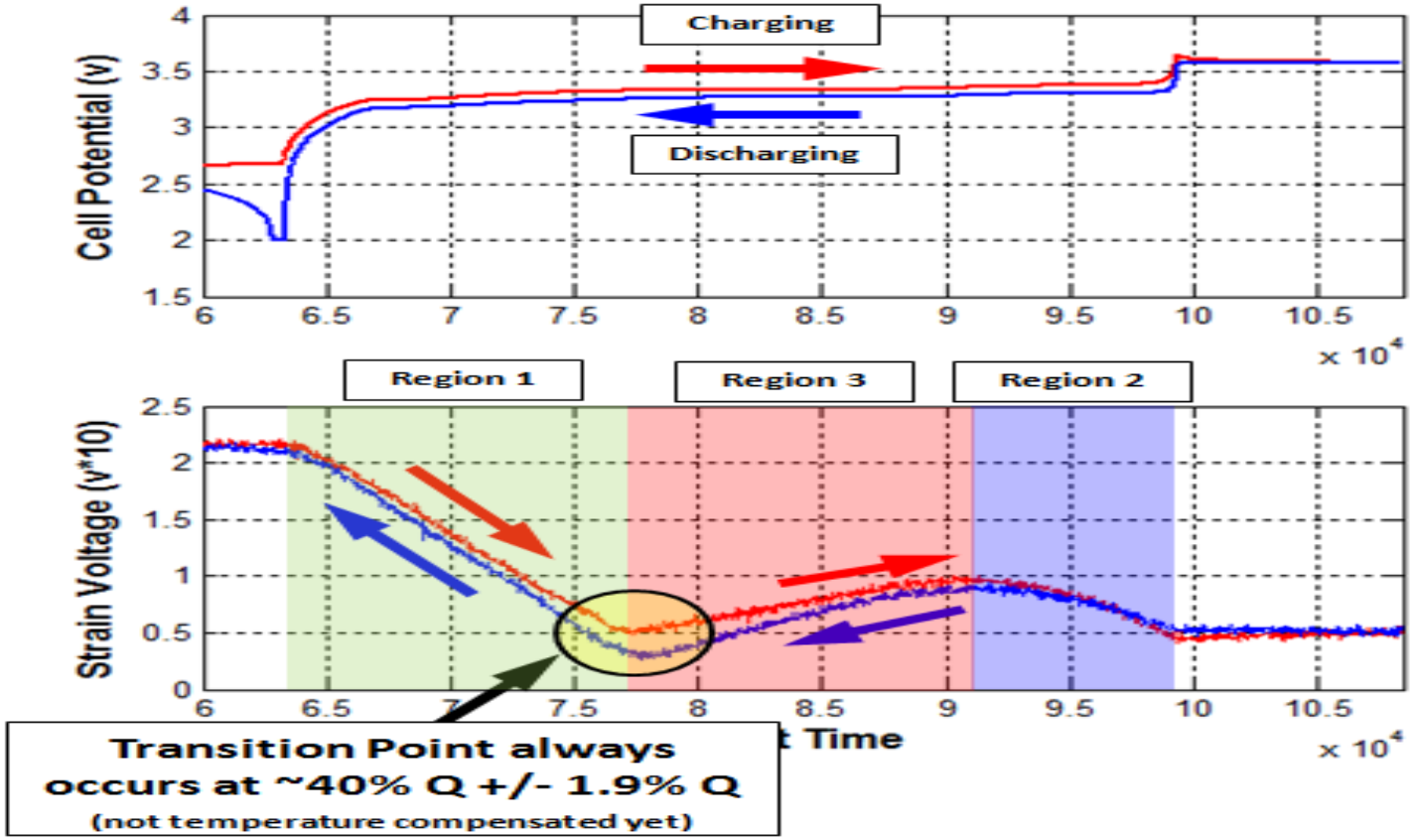
A Module Fixture Facilitating High-Current Charge/Discharge (up to 120 amps) in Controlled Temperature



DAQ and Real-Time Controller

Verification of Strain Signal Independence on Charge and Discharge Currents

- Distinct regions of operation define the SOC more clearly than conventional methods



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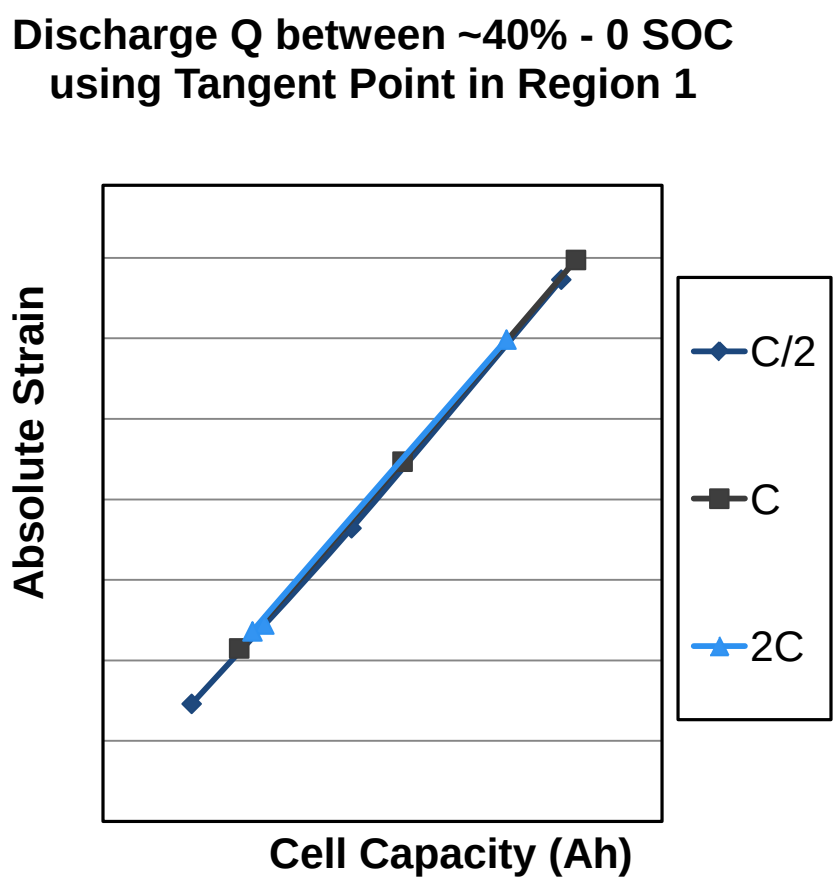

- The relationship in Region 1 is VERY linear and the transition from Region 2 to Region 3 is characterized by a maximum (i.e., strain rate plateau and changes size)
- It is believed that cycle life testing of the cells will reveal further characteristics that will be good indicators of the degradation