Cell Engineering of Sodium-Ion Pouch Cells for Enhanced Performance

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Topic: Sodium Batteries
Vertical: Materials and Systems Innovation
Strategic Pathways: Grow
Project start date: FY24 -FY25

Background

Introduction

Sodium-ion batteries (SIBs) are emerging as a compelling substitute for conventional battery technologies, driven by their use of abundant and low-cost raw materials. As concerns surrounding energy security, resilient supply chains, and geopolitical dependence continue to grow, SIBs offer a promising pathway toward more sustainable and widely accessible energy storage solutions.

Current Research Status

This project focuses on a demonstration platform to evaluate the performance, scalability, and manufacturability of sodium-ion battery (SIB) technology at capacities above 1 Ah. Cells at this scale provide meaningful data on cycle life, coulombic efficiency, thermal behavior, and electrode–electrolyte compatibility under realistic conditions. The work serves as an important step toward commercial-scale validation of SIB technology.

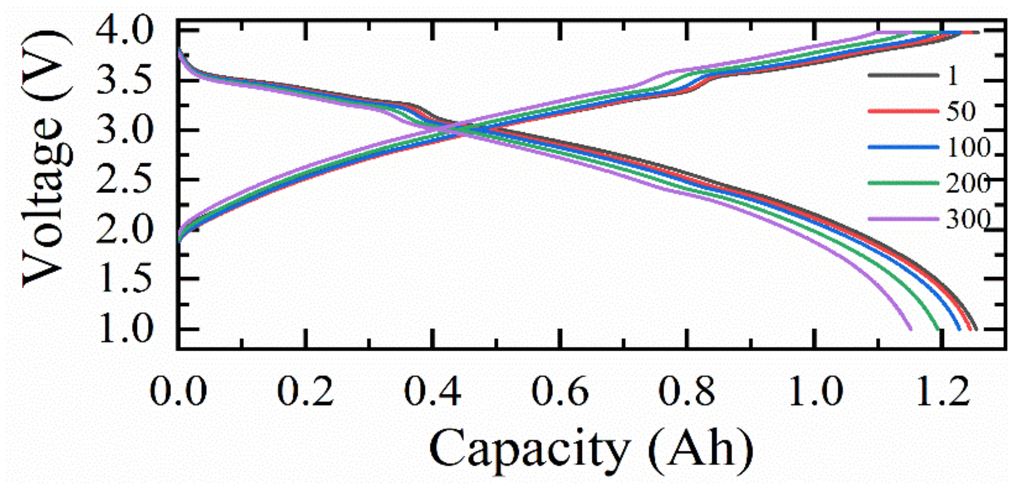
Project Goal & Milestones (FY25)

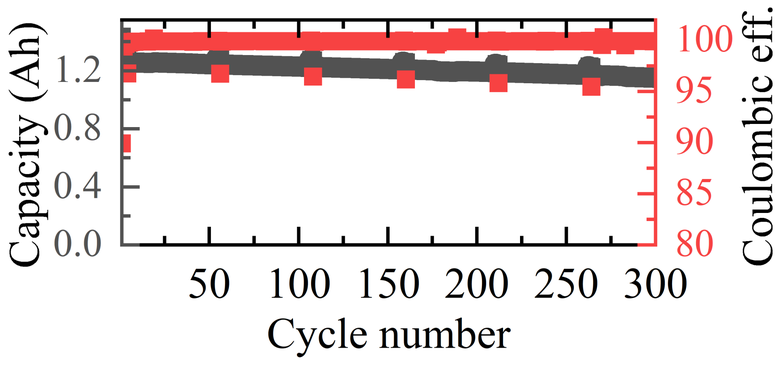
- ❑ Demonstrate pouch cell with 1Ah capacity
- ❑ Achieve 140 Wh/kg specific energy density
- ❑ Achieve >80% over 300 cycles
- ❑ Achieve <90 $/kWh

Approach

This project evaluates the practicality of SIB technology through the design and testing of pouch cells built with cost-effective, high-performance materials and manufacturing processes compatible with existing industry standards.

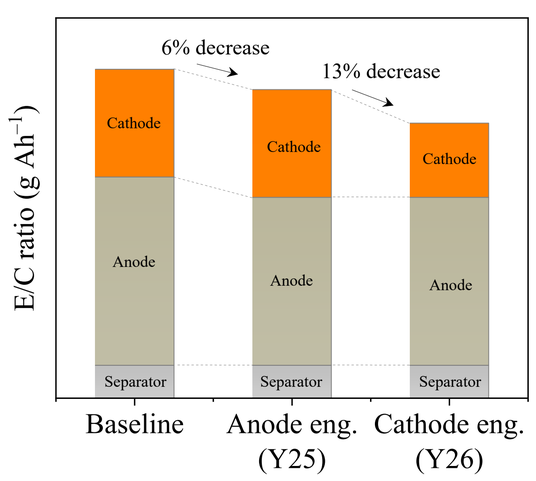
1Ah Pouch Cell Demonstration

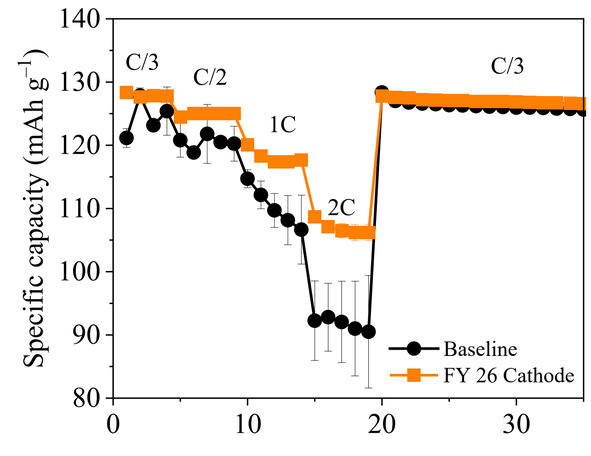


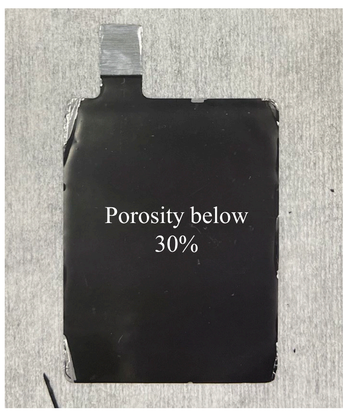


- ❑ $Na_xMn_{0.5}Ni_{0.4}Fe_{0.1}O_2$||HC pouch cell with > 3 mAh cm^{-2}
- ❑ Specific Energy: ~136 Wh kg^{-1}
- ❑ >1 Ah Sodium-ion pouch cell
- ❑ >92% capacity retention over 300 cycles

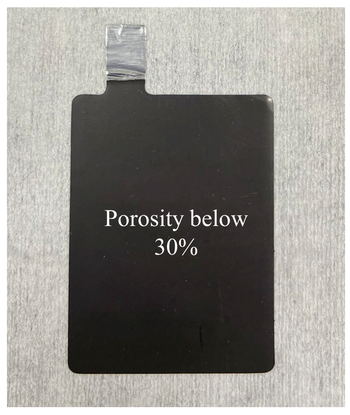
Cell Engineering to Improve Performance





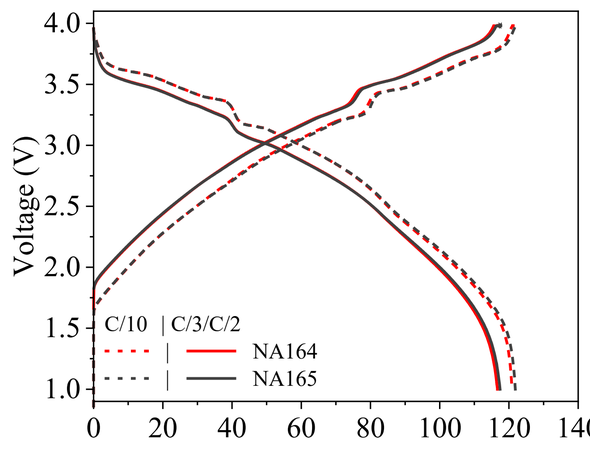


Electrode Engineering

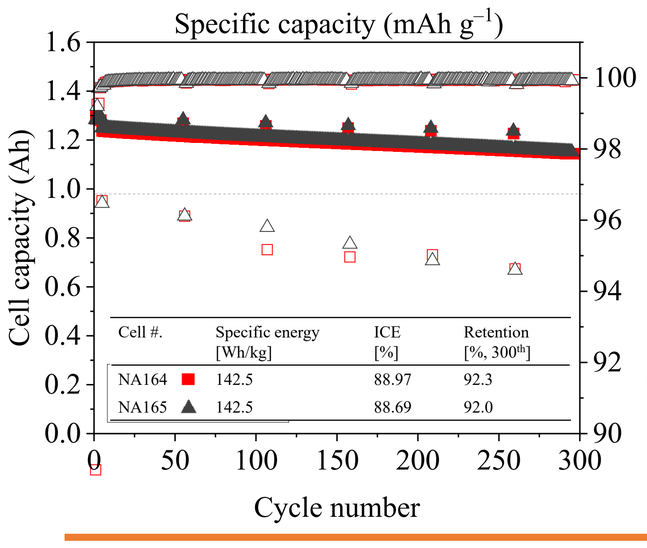


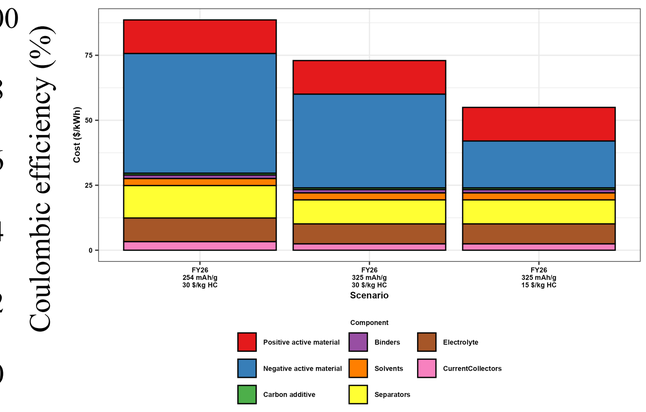
- ❑ Minimum electrolyte governed by pore volume.
  - ➢ Calendaring → Lower Porosity → Improved Performance
  - ➢ Lower Porosity → Poor Electrode Stability → Electrode Engineering Needed

140 Wh kg^{-1} Pouch Cell Demonstration



- ❑ Reproducible Pouch Cells
  - ➢ ~122 mAh g^{-1} (>1Ah)
  - ➢ Specific Energy: ~143 Wh kg^{-1}
  - ➢ 92% capacity retention after 300 cycles
- ❑ Cost Analysis
  - ➢ $Na_xMn_{0.5}Ni_{0.4}Fe_{0.1}O_2$||HC pouch cell priced at ~$55/kWh





Alignment

This project is accelerating the development and testing of a new energy storage technology that is more cost-effective, safe, and durable, which is crucial to meeting the Administration's goal of providing reliable, affordable, secure, and resilient energy.

Acknowledgement

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