Realistic Demonstration of Sodium-Ion Pouch Cells for Secure Energy Storage

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Background

Introduction

Sodium-ion batteries are emerging as a practical alternative to long-standing battery technologies, offering advantages in terms of material abundance, cost and scalability. At a time when energy independence, national security, and supply chain resilience are of paramount concern, SIB's stands out for its reliance on widely available and inexpensive raw materials which are not limited to geopolitically sensitive regions.

Current Research Status

Focusing on relevant demonstration which evaluates the performance, stability, and manufacturability of SIB technology at > 300 mAh cell level. These cells are large enough to provide meaningful data on practical performance metrics such as cycle life, coulombic efficiency, thermal behavior, electrode/electrolyte compatibility under realistic conditions. This project is a critical intermediate step in advancing the technology for large-scale readiness.

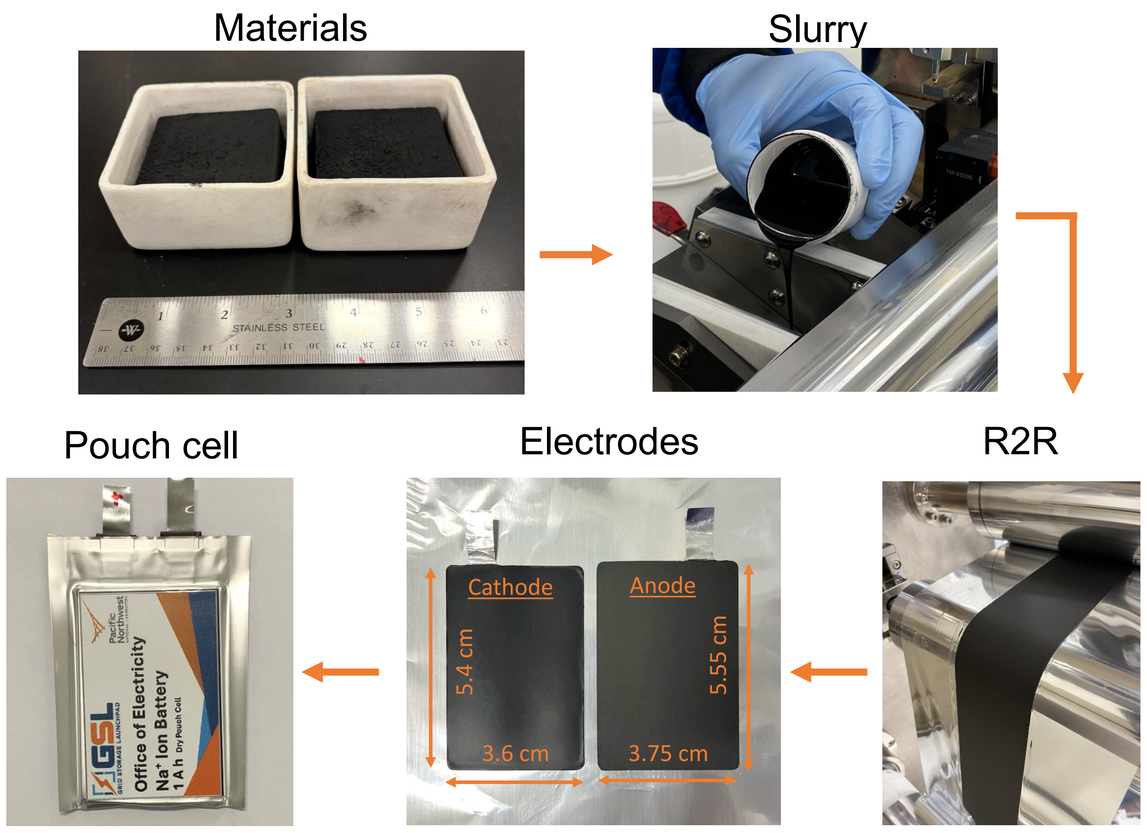
Project Goal & Milestones (FY25)

- ❑ Scale-up PNNL materials.
- ❑ Demonstrate pouch cells with ~500 mAh capacity capable of achieving $95/kWh materials cost.
- ❑ Developing next-generation cathode material with lower Ni content.

Approach

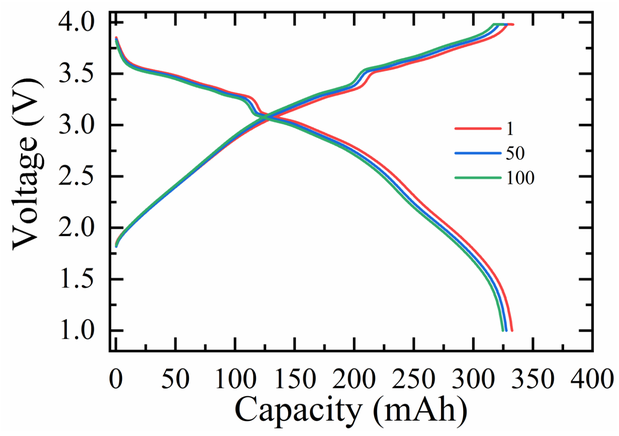
This project tests the feasibility of sodium-ion technology by developing and testing pouch cells using low-cost and high performing materials with industry compatible fabrication methods.

Materials Scale-up for Pouch cell Assembly

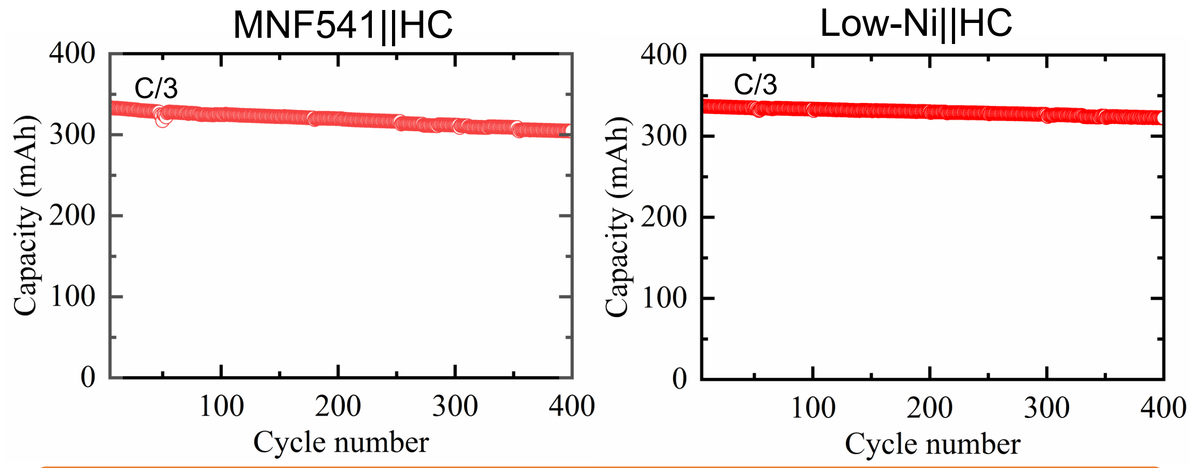


- ❑ Synthesize ~200-gram batches of baseline cathode material ($Na_xMn_{0.5}Ni_{0.4}Fe_{0.1}O_2$).
- ❑ Electrode materials mixed with conductive additive and binder.
- ❑ Slurry casted on roll coater and dried to yield electrode sheet (single or double side).
- ❑ Electrodes are punch from electrode sheet and assembled into pouch cell

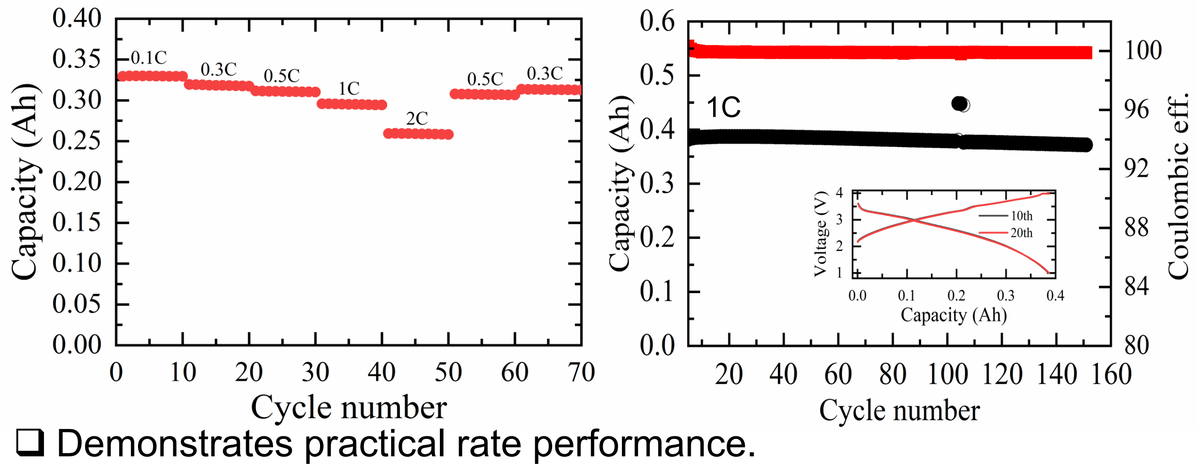
Cycling Stability of >300 mAh Pouch Cells



- ❑ Voltage Curve
  - ➢ High ICE ~90%
  - ➢ Low polarization when going from 1st – 100th cycle
- ❑ Stable cycling performance
  - ➢ CE = 99.9%
  - ➢ ~92% capacity retention @400 cycles

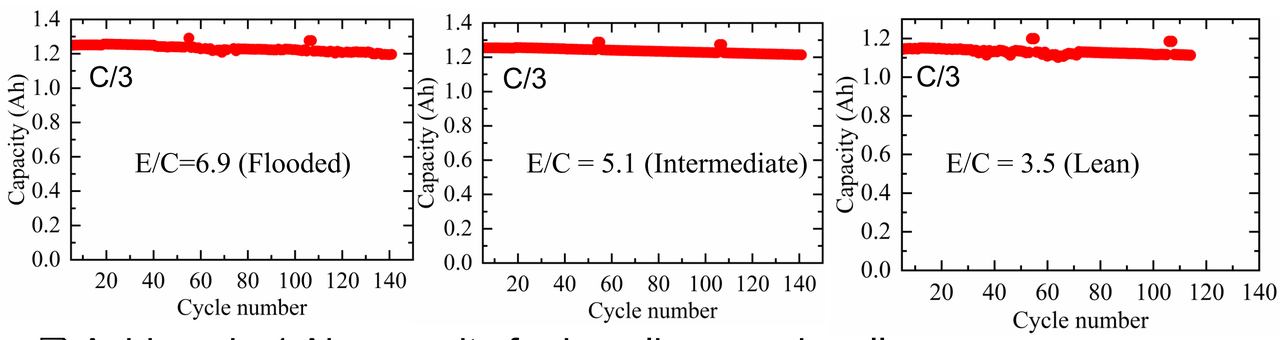


Rate Capability of >300 mAh Pouch Cells



- ❑ Demonstrates practical rate performance.
  - ➢ Delivers 97%, 94%, 89% and 79% of 0.1C capacity at 0.3C, 0.5, 1 and 2C rate.

Tuning Electrolyte Quantity in >1Ah Pouch Cells



- ❑ Achieved >1 Ah capacity for baseline pouch cell.
  - ➢ Lean condition improves safety and energy density from 132 to 149 Wh/kg

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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