# MECHANISTIC ASSESSMENT OF HIGH-ENERGY AND EARTH-ABUNDANT BATTERY CHEMISTRIES

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| PROJECT PROFILE |
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| Topic: Safety & Reliability \| Vertical: Safety & Reliability<br>Strategic Pathway: Optimize<br>Project start and finish: FY25-FY26 |

## PROBLEM

High-energy and earth-abundant battery chemistries are rapidly commercializing for use on the grid; however, mechanistic safety understanding lags the development of the chemistries. This produces several open questions for these new chemistries:

1) How tolerant to abuse are these new chemistries?
2) What is the failure mechanism?
3) How do the hazards change relative to Li-ion?
4) Will current diagnostics work adequately?
5) Are new hazard mitigation strategies required?

## APPROACH

Safety of earth-abundant Sodium-ion Batteries (NIB) was assessed using a multi-scale approach consisting of:

- Materials thermal analysis and characterization
- Coin cell thermal analysis
- Single cell abuse testing in SNL Battery Abuse Testing Laboratory

High-energy solid state battery safety was predicted using materials thermal analysis and characterization

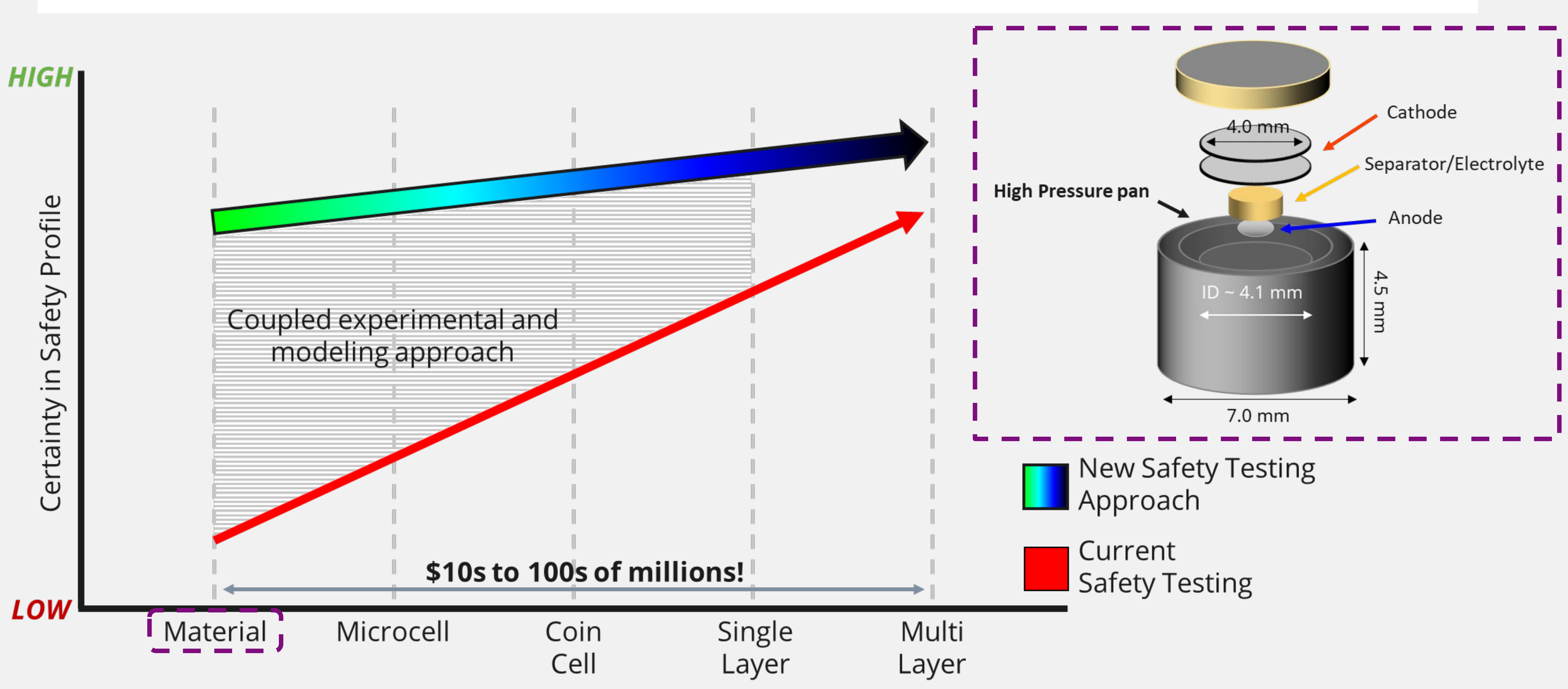


*Fig. 1. Schematic demonstrating benefits and methods of materials scale safety analysis.*

## RESULTS

- NFM has similar failure mechanism to NMC.
- NFM releases 35% more energy per kWh.
- DSC shows close agreement with 18650 abuse

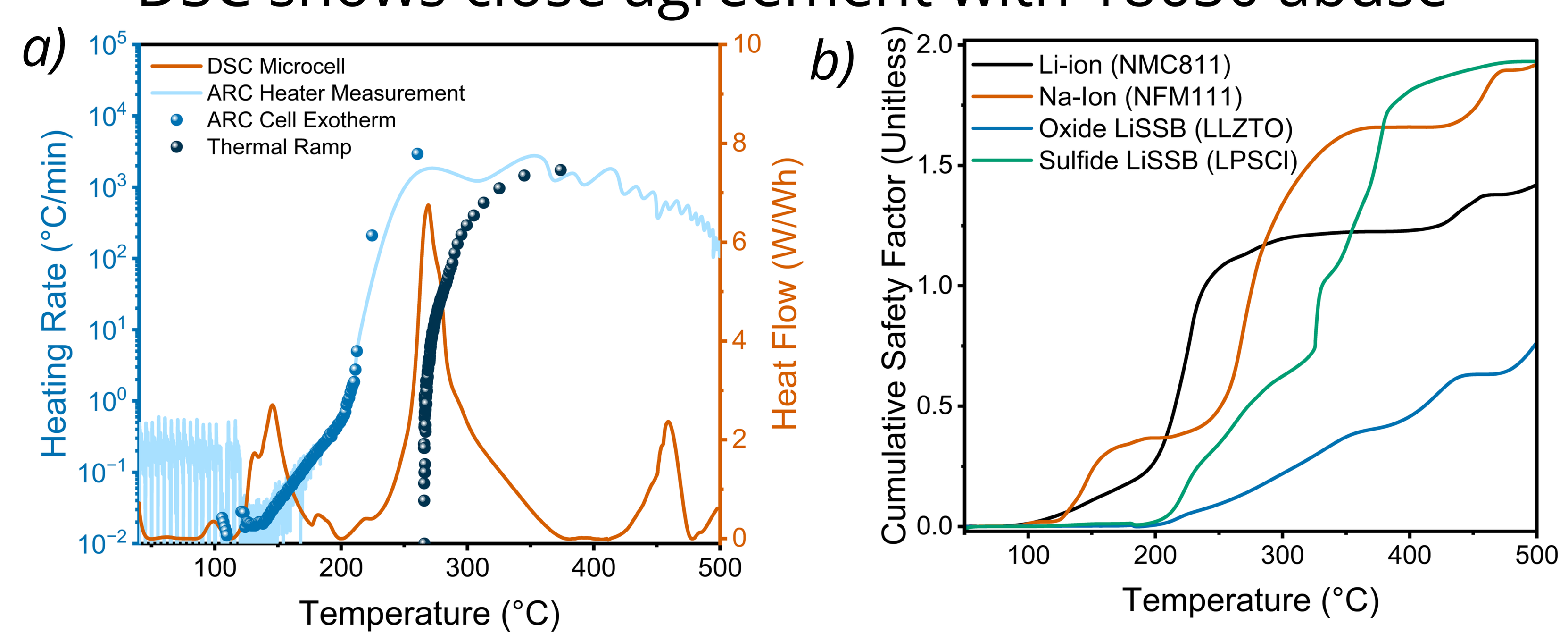


*Fig. 2. DSC results show a) mechanistic interpretation of single cell abuse testing and b) a comparison of next-generation chemistries benchmarked against an NMC LIB*

## CONCLUSIONS & IMPACT

- 35% more energy release indicates NFM NIBs may have more severe failure than NMC LIBs
- Nearly identical failure mechanism of analogous NIB materials suggests no new hazards
- Diagnostics for current LIBs will likely still be effective for NIBS
- SSB and other chemistries may need new diagnostics developed

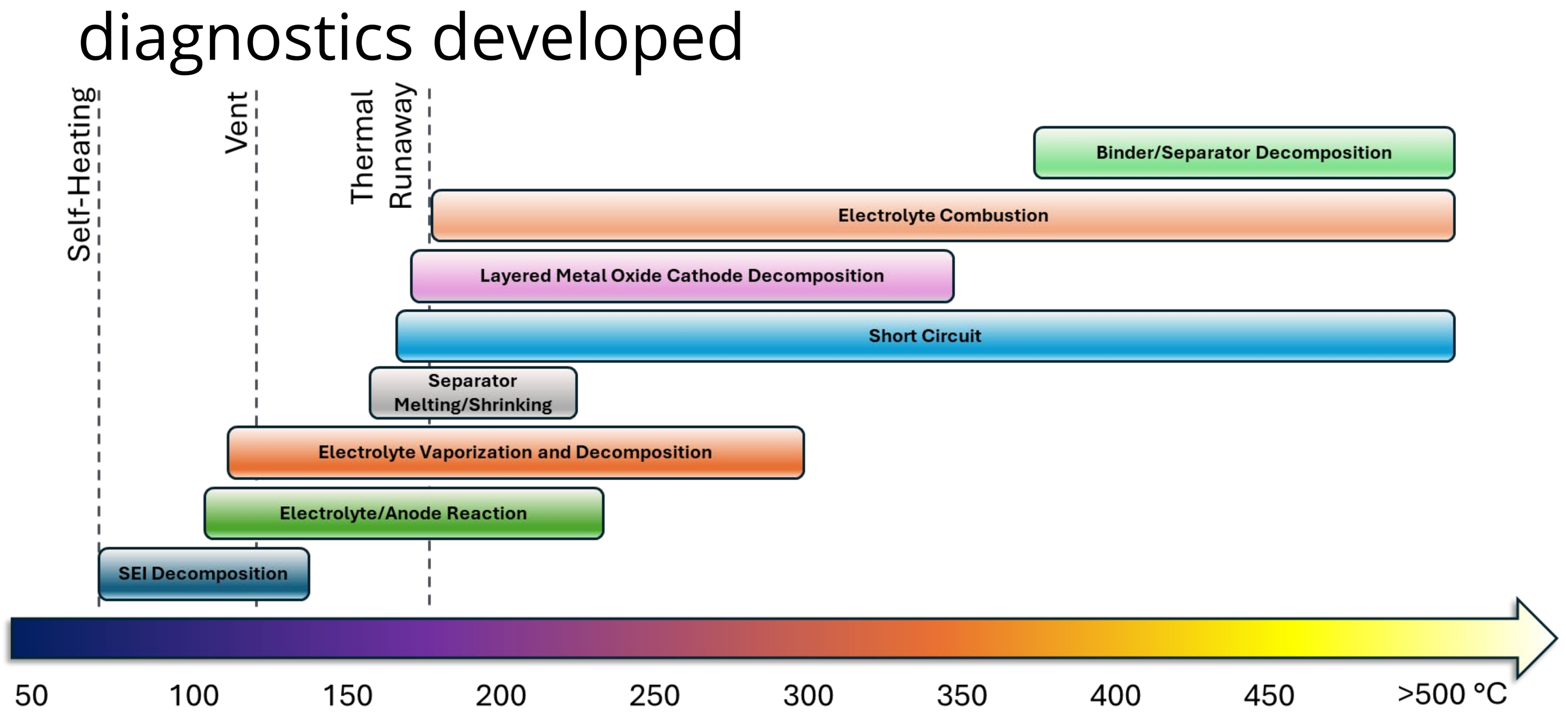


*Fig. 3. Thermochemical failure mechanism of NFM NIB*

## FUTURE DIRECTIONS

- Quantify vented gasses from common NIBs
- Assess diagnostic effectiveness for NIB and next-generation chemistries
- Perform safety assessment of other common NIBs such as Polyanion and Prussian Blue Analogues

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