Sandia National Laboratories

# Are Solid-State Batteries Safer Than Lithium-ion Batteries?

Alex M. Bates[1], Megan Diaz[2], Yuliya Preger[2], Loraine Torres-Castro[1], Randy Shurtz[3], John Hewson[3]

## Motivation

- Is there a pathway for significant heat release and high temperature failures in an all-solid-state battery (ASSB)? Or are they inherently safe?
- What is the impact on heat release if liquid electrolyte (LE) is used to facilitate Li-ion transport at the cathode and solid electrolyte (SE) interface?

## Background

Solid-state batteries (SSBs) offer the potential for a safer and high energy density alternative to conventional Li-ion batteries (LIBs), achieved through the replacement of flammable LE with a non-flammable solid electrolyte and enabling Li-metal as an anode. A major challenge facing SSBs is interfacial resistance. This challenge may be resolved through the use of LE. However, LE use raises concerns over safety impact. Additionally, ASSB safety is often taken for granted.

## Results

Failure Scenarios
A. External Heating
B. Internal Short Circuit
C. SE Mechanical Failure

Abbreviation Key
All-Solid-State Battery – ASSB
Solid-State Battery – SSB
Li-ion Battery - LIB

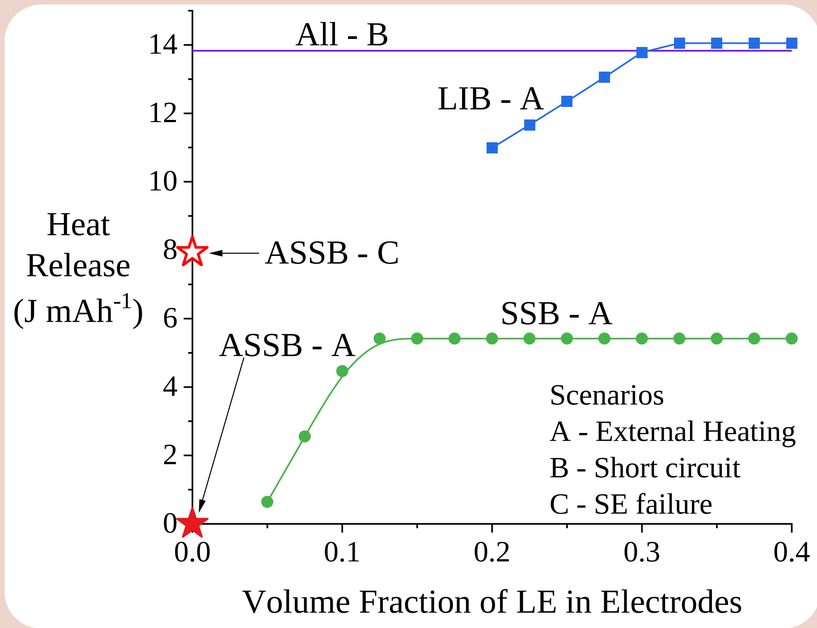



Figure 1. Heat release dependence on LE volume.

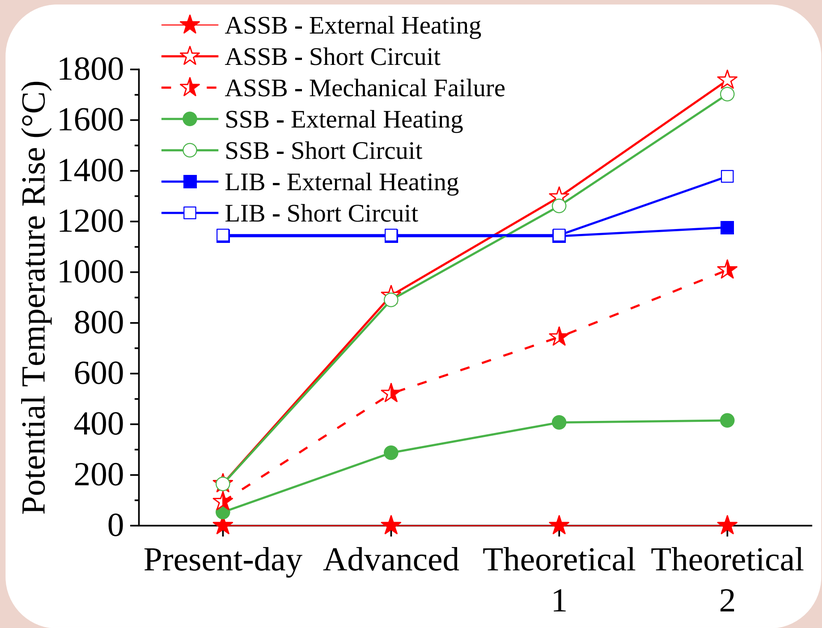



Figure 2. Potential temperature rise increasing with energy density.

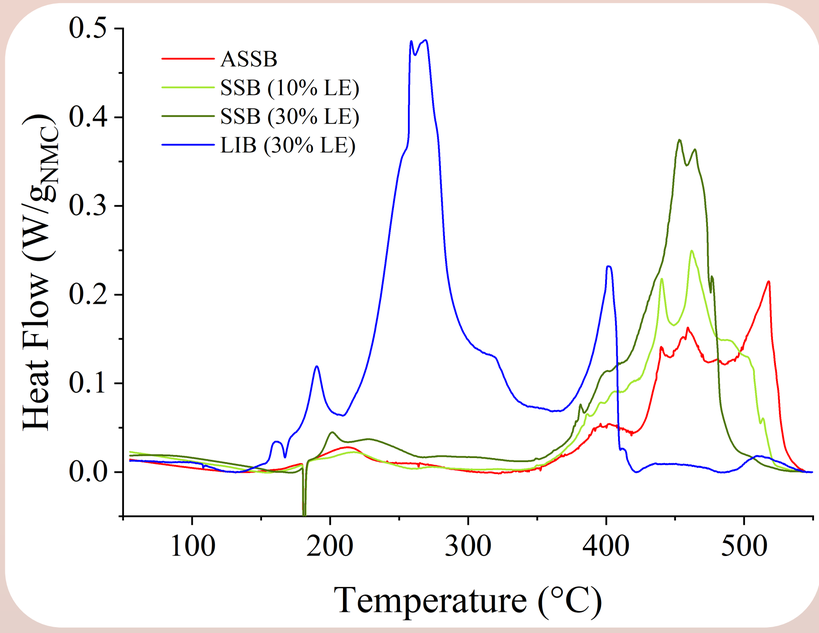



Figure 3. Heat flow signatures from Differential Scanning Calorimetry of microcells.

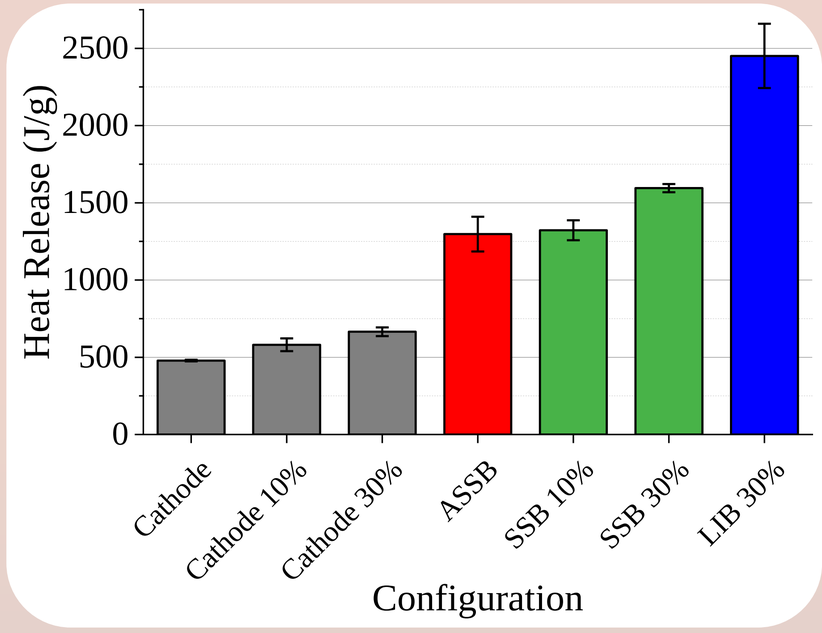
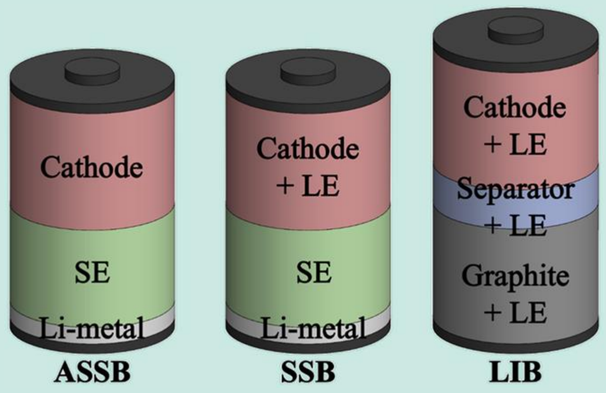


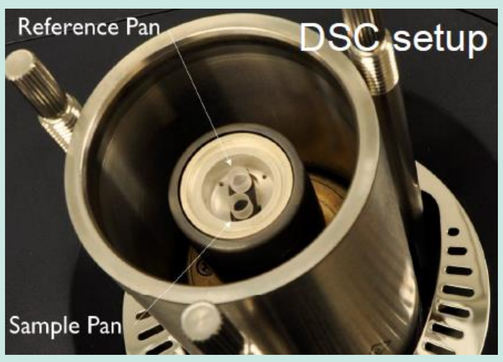

Figure 4. Overall heat release of each configuration with three repeats per type.

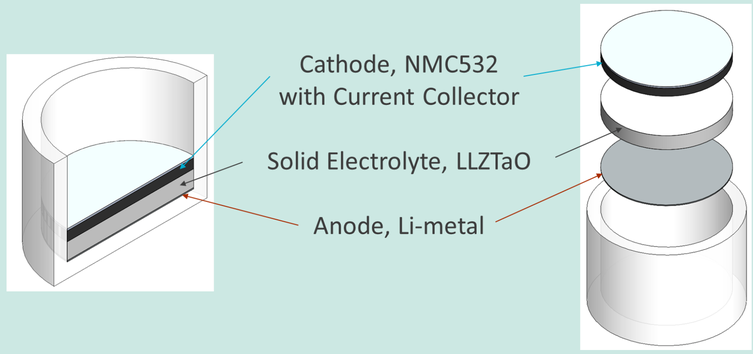
## Methods

### Thermodynamic Modeling




### Experimental




## Take-Aways

- SSBs are not ALWAYS inherently safe
- Specific heat release will become a critical consideration
- SE mechanical failure is a pathway for significant heat release in an ASSB
- Low enough LE volume may lead to an acceptable tradeoff
- Experimental trends indicate higher onset temperatures to large exothermic heat release for both ASSB and SSB

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Let's Connect!
www.linkedin.com/in/alex-bates
ambates@sandia.gov

[1]Power Sources R&D, Sandia National Laboratories, Albuquerque, NM
[2]Energy Storage Tech & Systems, Sandia National Laboratories, Albuquerque, NM
[3]Fire Science and Technology, Sandia National Laboratories, Albuquerque, NM



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