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Sandia National Laboratories

Presented by Megan Diaz[2]

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

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Motivation

- What pathways exist for significant heat release in an all-solid-state battery (ASSB) and what is the magnitude of the heat release?
- 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 higher energy density alternative to conventional Li-ion batteries (LIBs), achieved through the replacement of flammable LE with a non-flammable SE and by enabling Li-metal as an anode. A major challenge facing SSBs is interfacial resistance between the SE and the electrodes. 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

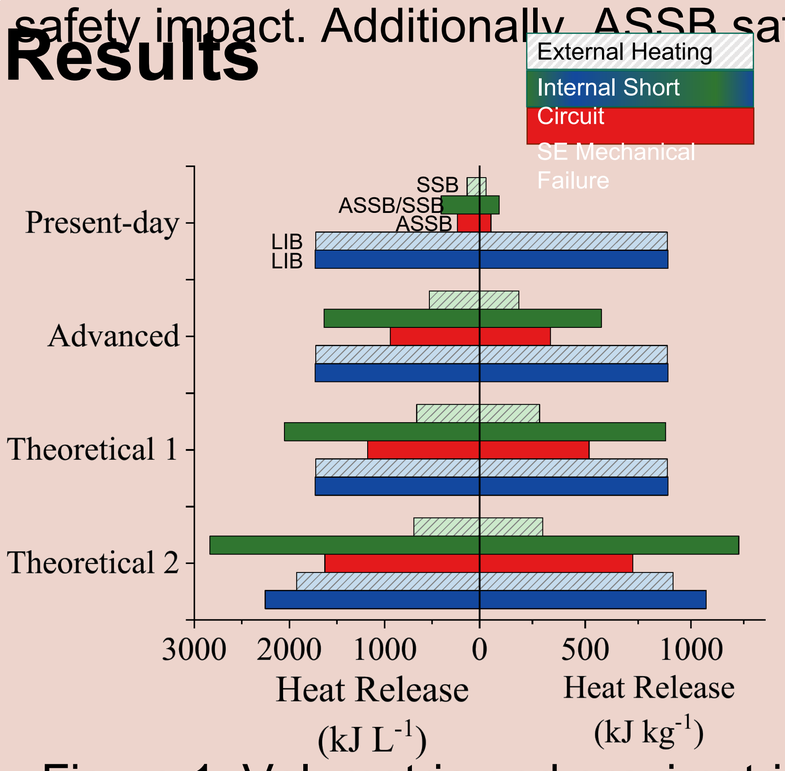


Figure 1. Volumetric and gravimetric heat release as a function of energy density.

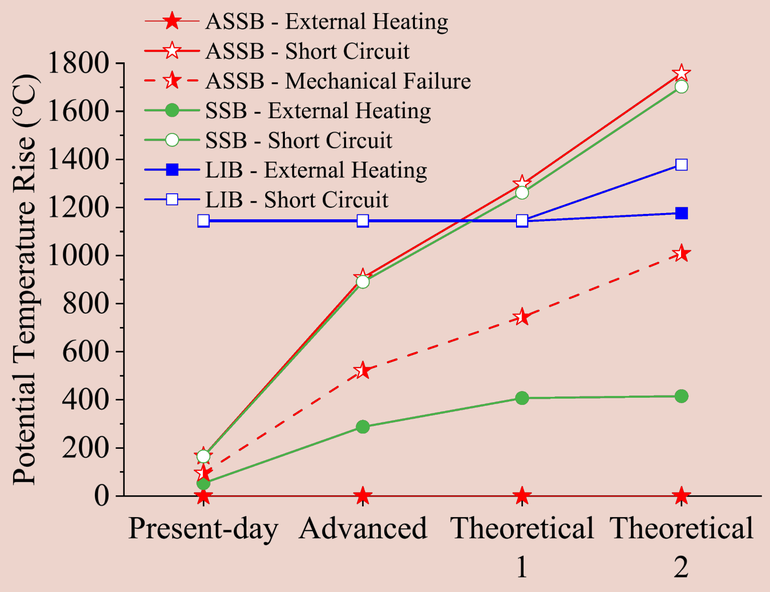


Figure 2. Potential temperature rise increasing with energy density.

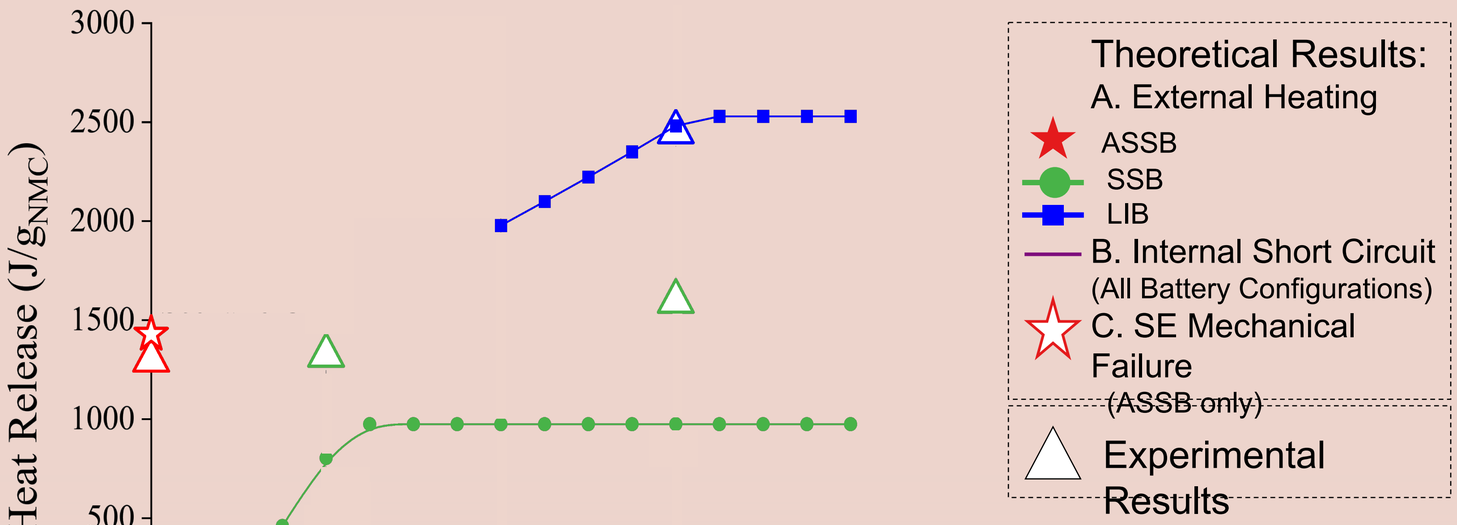
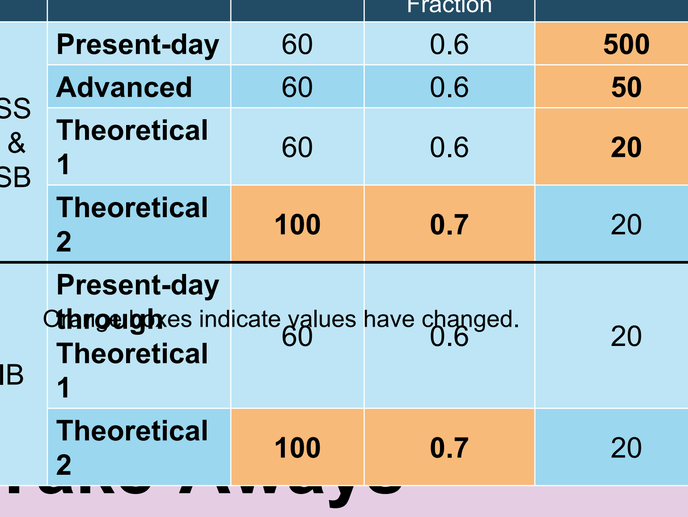


Figure 3. Comparison of theoretical and experimental results in terms of specific heat release.

Methodology

Battery Configurations



*SE: $Li_7La_3Zr_2O_{12}$ (LLZO)

Failure Scenarios

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

Formats

		Cathode		SE/Separator
	Format	Thickness (µm)	Active Material Volume Fraction	Thickness (µm)
ASSB & SSB	**Present-day**	60	0.6	**500**
	Advanced	60	0.6	**50**
	Theoretical 1	60	0.6	**20**
	Theoretical 2	**100**	**0.7**	20
LIB	**Present-day through Theoretical 1**	60	0.6	20
	Theoretical 2	**100**	**0.7**	20

Changed values indicate values have changed.

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 follow thermodynamic modeling

Next Steps

- Expand to other SE chemistries
- Perform in depth investigation into decomposition reactions

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