Are Solid-State Batteries Safer Than Lithium-ion Batteries?
Megan Diaz1, Alex M. Bates2, Yuliya Preger3, Loraine Torres-Castro2, Randy Shurtz3, Katharine L. Harrison4, Stephen J. Harris1, John Hewson5

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

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

1Energy Storage Tech & Systems, Sandia National Laboratories, Albuquerque, NM
2Power Sources R&D, Sandia National Laboratories, Albuquerque, NM
3Fire Science and Technology, Sandia National Laboratories, Albuquerque, NM
4Nanoscale Sciences Department, Sandia National Laboratories, Albuquerque, NM
5Energy Storage Division, Lawrence Berkeley National Laboratory, Berkeley, CA

Funded by the U.S. Department of Energy, Office of Electricity, Energy Storage program. Dr. Imre Györy, Program Director. S.J.H. was supported by the Assistant Secretary for Energy Efficiency, Vehicle Technologies Office of the US Department of Energy under the Advanced Battery Materials Research program.

Footnotes
[4]Nanoscale Sciences Department, Sandia National Laboratories, Albuquerque, NM
[5]Energy Storage Division, Lawrence Berkeley National Laboratory, Berkeley, CA

References

Acknowledgments
- The authors would like to thank the Department of Energy's National Nuclear Security Administration for funding this research.

Contact Information
megan.diaz@sandia.gov
www.linkedin.com/in/megan-diaz-sandia
mregan@sandia.gov
aubin@sandia.gov