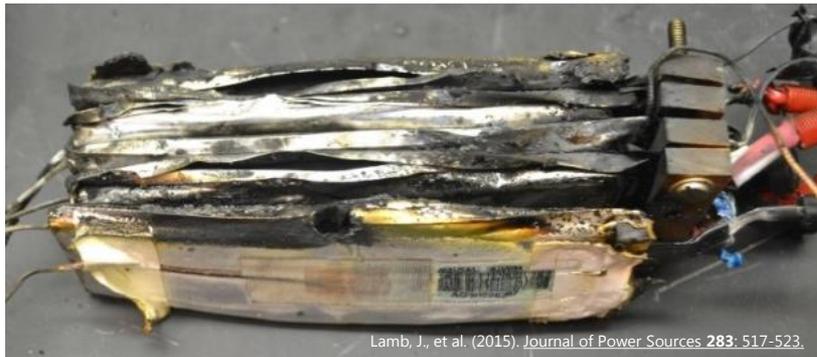
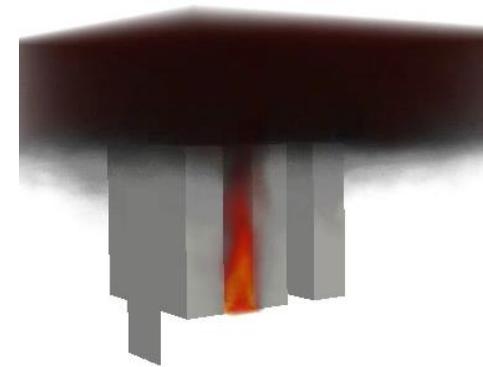
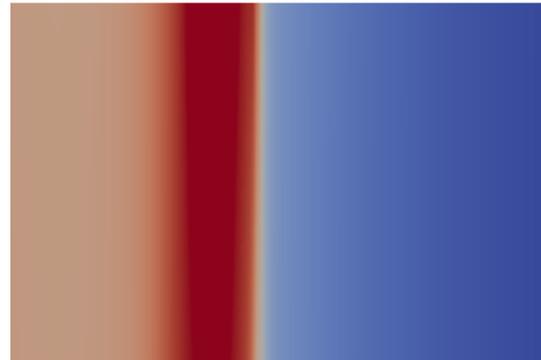


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Lamb, J., et al. (2015). *Journal of Power Sources* **283**: 517-523.



UNDERSTANDING THE LIMITS OF THERMAL RUNAWAY IN LITHIUM-ION BATTERY SYSTEMS

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Sandia National Laboratories is a multi-mission laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2016-9332 C

Modeling Li-Ion Thermal Runaway

Background

- Energy storage in electrochemical systems (batteries) is increasingly prevalent
- Potential hazards associated with stored energy couple with inexperience regarding safety and mitigation practices
 - Magnitude of thermal and chemical hazards?
 - What are ignition criteria? appropriate mitigation?
- Standards and best practices need to be developed

Modeling Thermal Runaway

- Calorimetry forms basis for understanding thermal runaway
- Kinetic Parameters extracted from calorimetry can be evaluated in single-cell oven test configuration (below)
- Larger scale systems can also be evaluated using these kinetic parameters in more complex models

Cascading Cell Failure

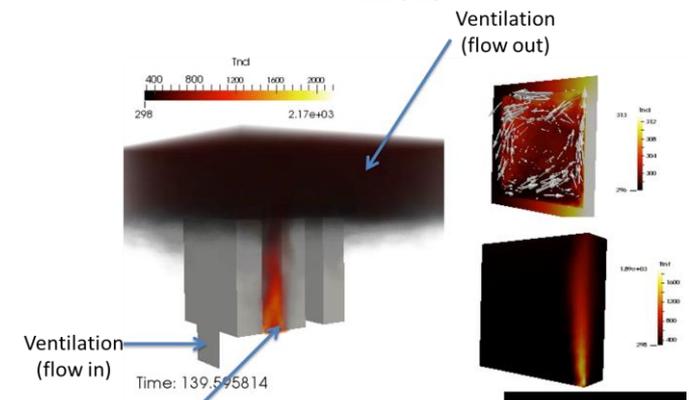
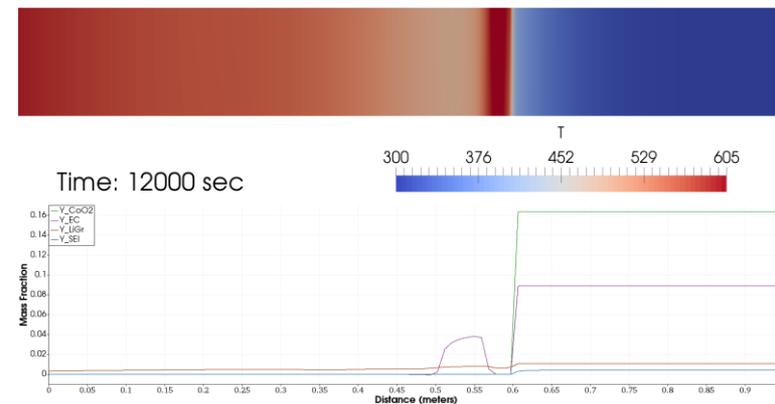
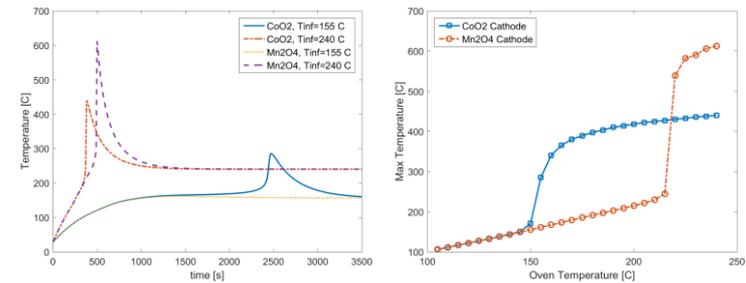
- Failure of a single cell can lead to failure of neighboring cells
 - Occurs when heat generation rates exceed heat losses
 - Preheat zones can lead to pulsating propagation, similar to premixed flames

Understanding facility-scale hazards using CFD

- The simulation tool predicts the thermal environment that balances cell internal heat release and decomposition kinetics
 - Opens some parameter space to exploration.
 - Identifies sensitivities to heat-dissipation strategies, insulation, ventilation, etc.

In closing

- Thermal runaway in batteries is a significant financial risk and barrier to consumer acceptance
- Sandia experience and investment in multiphysics codes significantly overlaps battery thermal runaway challenges
- Simulation tools suggest opportunities to dissipate thermal and electrical energy and mitigate/suppress thermal runaway



Fire modeled as a combustible hydrocarbon