

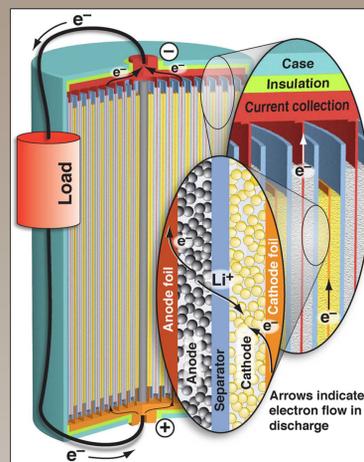
UNDERSTANDING THE LIMITS OF THERMAL RUNAWAY IN LITHIUM-ION BATTERY SYSTEMS

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Background

- Energy storage in electrochemical systems (batteries) is increasingly prevalent.
 - Energy storage facilities from 3kWhr to MWhr scale.
 - Vehicle battery systems like 'gas tank' at 50 kWhr.
 - Laptops, etc., with ≈ 60 Whr.
- 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.

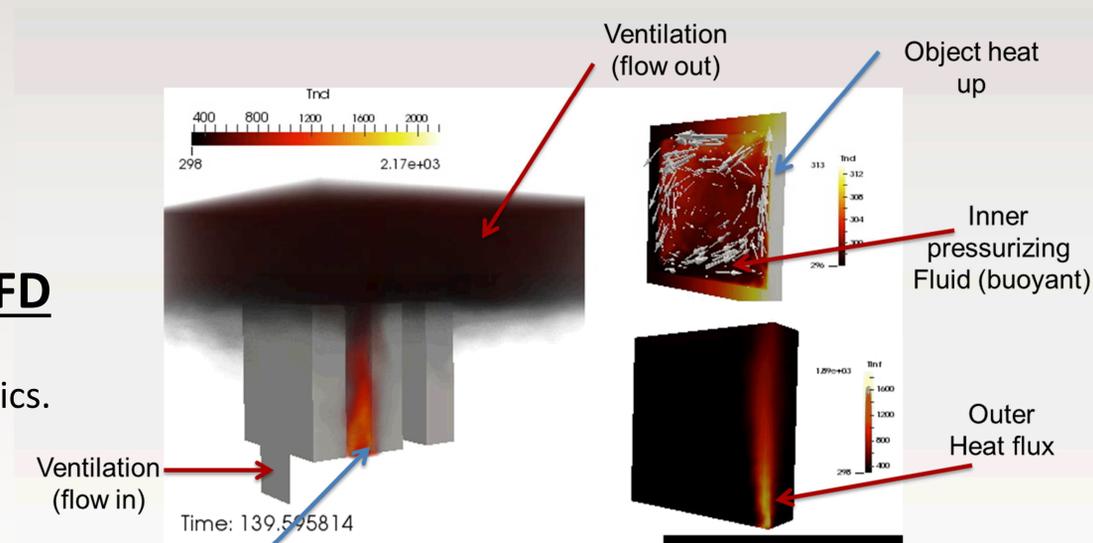
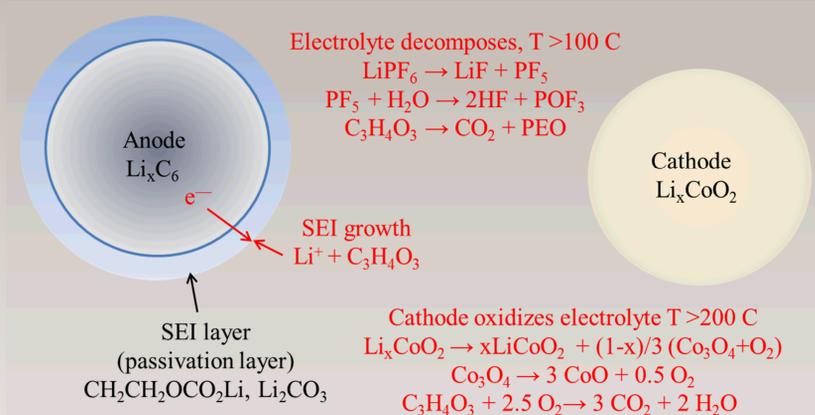
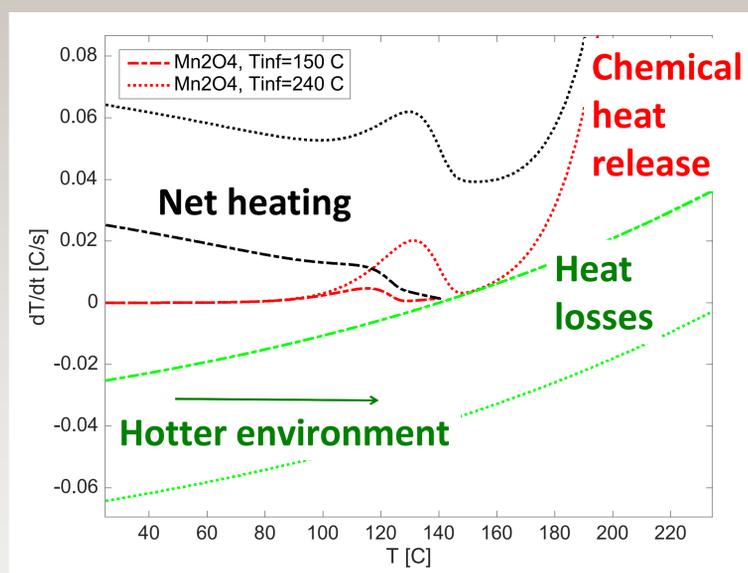


Cell chemistry

- Charged batteries include a 'fuel' and 'oxidizer' all internally.
- Other materials including electrolyte and packaging are often flammable.
- External heating or internal short circuits can lead to thermal runaway.

Liquid electrolyte
 $C_3H_4O_3, LiPF_6$

Thermal runaway when heat release exceeds losses



Fire modeled as a combustible hydrocarbon

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.