

Safe, High Specific Energy & Power Lithium Ion Cell Designs

Eric Darcy 281-483-9055 eric.c.darcy@nasa.gov

HAT: 3.2.b-E, 3.2.c-E TA 3. Space Power and Energy Storage TRL: start 3 / current 5

OVERVIEW

This experimental effort determined the impact of several design features in a ubiquitous commercial cylindrical lithium ion cell standard for reducing the risk of uncontrolled cell can wall side wall rupture (SWR) during thermal runaway (TR). It also utilized novel test methods to gain insight in the mechanism of the SWR failure. A cell SWR can quickly defeat many other battery hazard mitigation features to prevent catastrophic cell TR propagation.

INNOVATION

New cell design features include

- Bottom vents
- Stronger, thicker can wall

New test methods utilized:

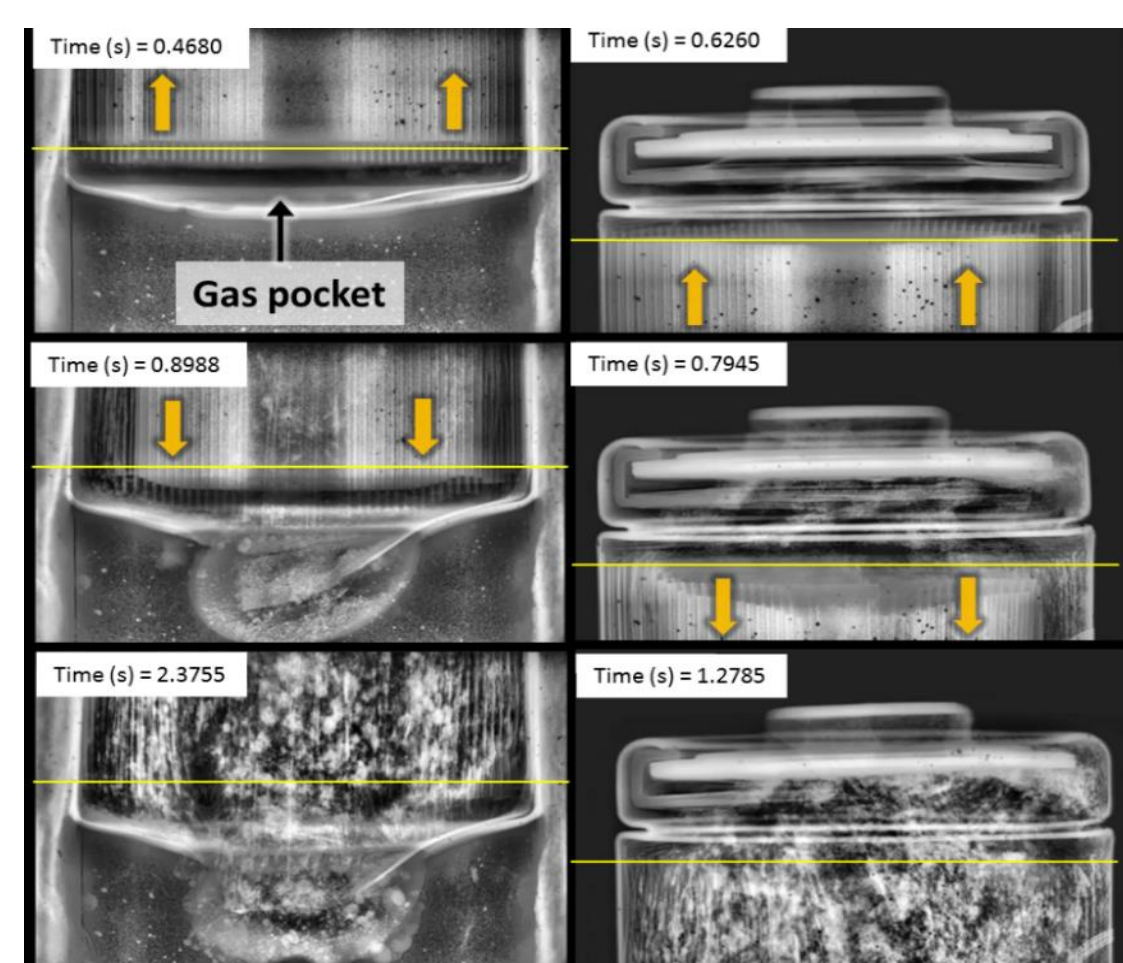
- Internal Short Circuit Device
- Cell TR Calorimeter
- Ultra High Speed Video X-rays

OUTCOME

- Both bottom vents and thicker can walls are beneficial and necessary
- Compelling high speed X-ray videos and calorimetry reveal TR failure mechanism and heat distribution

INFUSION SPACE / EARTH

- Compelling calorimetry and high speed X-ray videos will be influencing major 18650 Li-ion cell manufacturers worldwide to improve cell/battery safety and performance for NASA and terrestrial applications.

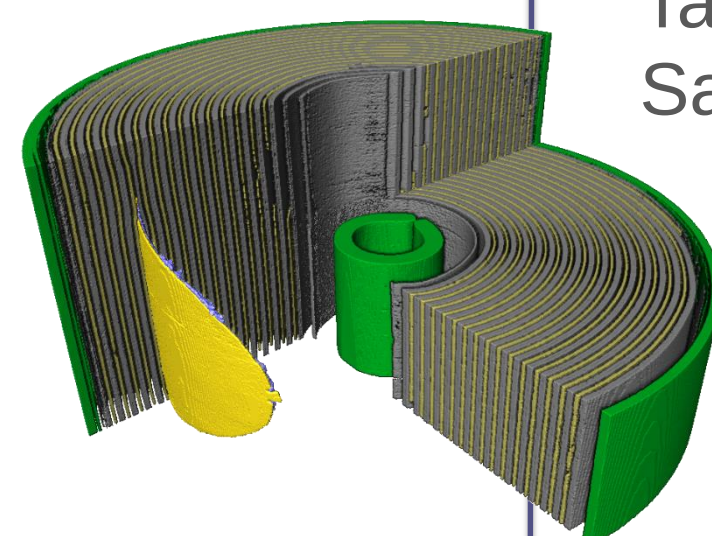


Ultra High Speed X-ray Videography

Stage 1:
Minor shift of
electrode assembly
and gas build-up
at base

Stage 2:
Bottom vent bursts
and major shift
towards base

Stage 3:
Thermal runaway with
ejection from top
and bottom vent



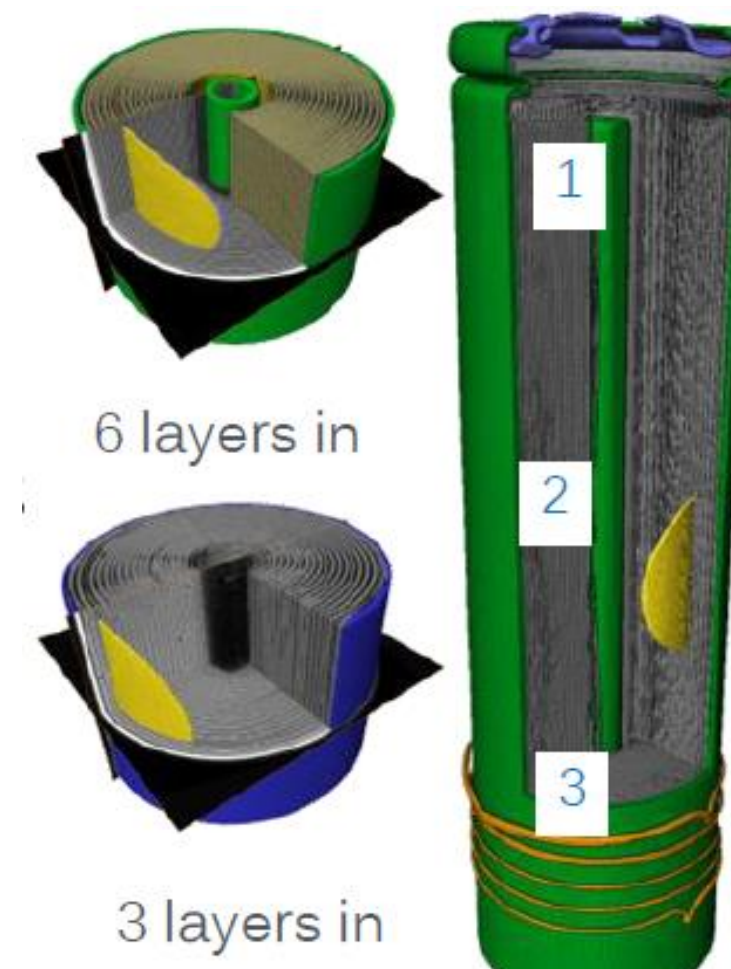
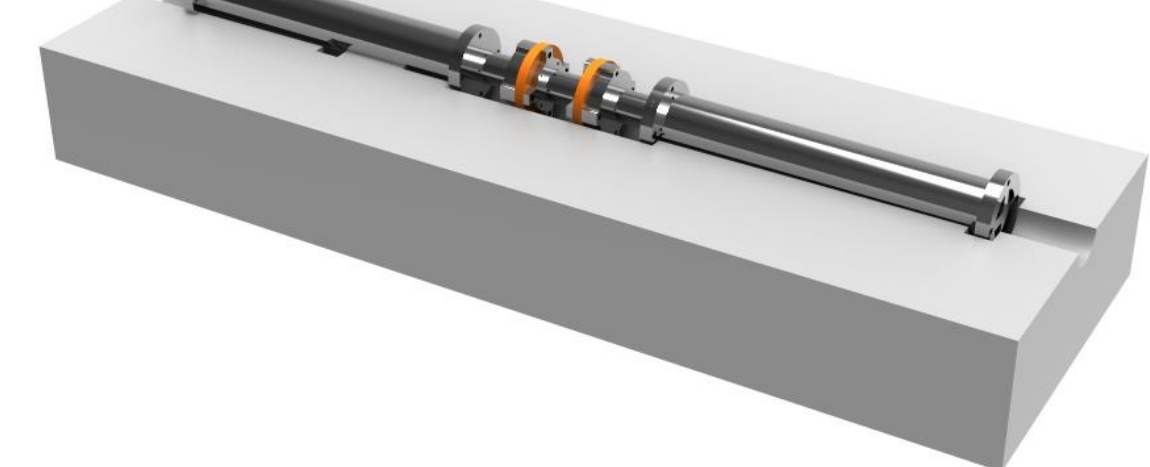
CT of ISC Device in Li-ion Cell

Graphics Credit: D. Finegan/NREL

Cell Bottom Vent Feature



Cell TR Calorimeter



Varied the location
of ISC Device

PARTNERSHIPS / COLLABORATIONS

- National Renewable Energy Labs (NREL) for the internal short circuit device design/fabrication
- LG Chem for implanting device in their best performing 18650 cell designs
- University College of London (UCL) for leading the Synchrotron beam experiments

PAPERS / PRESENTATIONS

- Finegan, Darcy, et.al. "Characterizing TR by Inducing and Monitoring Internal Short Circuits within Li-ion Cells" *Energy Environ. Sci.* 2017, **10**, 1377
- Darcy and Finegan, "Merits of the Cell Bottom Vent Feature in 18650 Cells for Preventing Side Wall Rupture," *Battery Safety 2017*, Arlington, VA, Nov 2017.

FUTURE WORK

This results of this project are being leverage in a NESC Task Assessment for establishing design guidelines for Safe, High Power Batteries (NESC-17-01219)



European Synchrotron in France