2019

TEXAS
The University of Texas at Austin

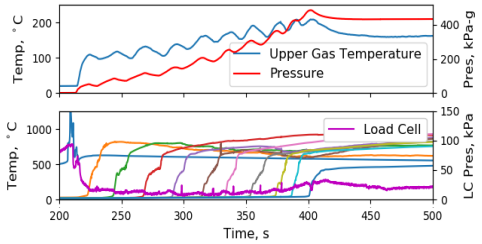
UTFRG FACILITIES AND CAPABILITIES

Lithium-ion Battery Safety

UT FIRE RESEARCH GROUP
The University of Texas at Austin
www.utfireresearch.com

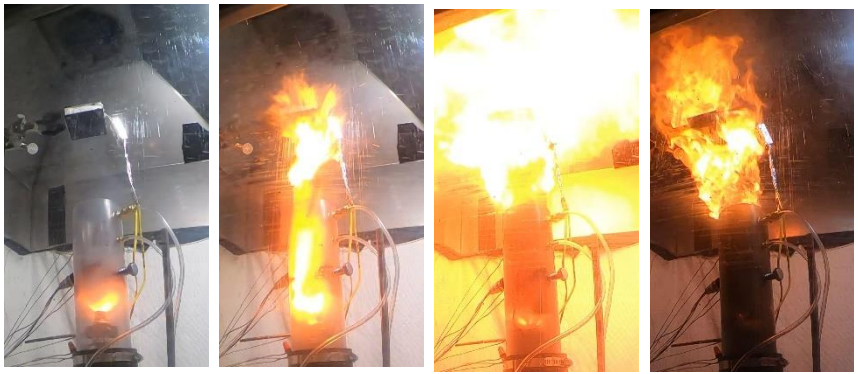
Small-Scale Abuse Testing

Understanding and characterizing thermal runaway dynamics of Li-ion cells is an important first step in evaluating the safety of Li-ion battery systems. UTFRG has several in-house capabilities to evaluate and characterize thermal runaway for single-cell and small multi-cell packs. The UTFRG LiB-VeGa (**Li**-**i**on **B**attery **Ve**nt **Ga**s Vessel) is our workhorse testing facility that allows our researchers to fully characterize thermal runaway dynamics and vent gas properties. UTFRG also provides custom designed testing and design of experiments (DOE) services.



Pressure and temperature characterization of thermal runaway propagation in 10Ah LCO pouch cells arranged in a ten-unit linear array (*top right*). Images are of the LiB-VeGa test vessel (*left*) and the the 10x10Ah array mounted in the LiB-VeGa prior to testing (*top right*).

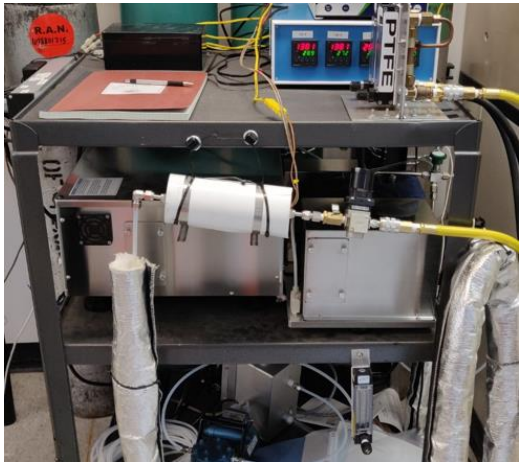
Image sequence of thermal runaway of an 18650 Li-ion cell in a custom experimental apparatus. The cell was failed in an inert coflow and temperature and heat flux were measured to characterize thermal properties.



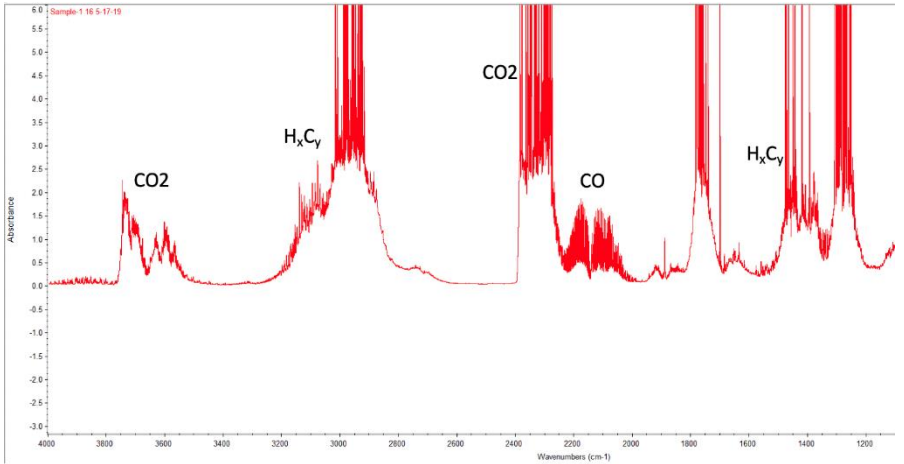
Li-ion Battery Vent Gas Characterization

Vent gases generated from a thermal runaway event poses significant fire and explosion hazards if left unmitigated. Effective design and evaluation of mitigation strategies requires characterization of the vent gas properties and gas venting dynamics. UTFRG's LiB-VeGa test facility has capabilities to characterize vent gas properties and venting dynamics. FTIR and GC capabilities provide gas speciation.

GC (*left*) and FTIR (*right*) systems provide online characterization of vent gases released during thermal runaway of Li-ion cell and packs failed in the LiB-VeGa facility.



Example spectra obtained from FTIR spectroscopy identifying CO, CO_2 and hydrocarbon species in the vent gases released from a Li-ion battery failed in the LiB-VeGa test facility.



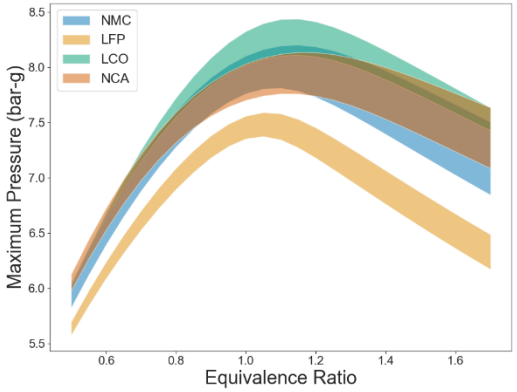
Large-Scale Safety Testing

Large battery systems used in energy storage and automotive applications can consist of thousands of individual cells. The overall fire and explosion hazard depends on the battery system design features and integrated safety systems. UTFRG has two large-scale burn facilities that can accommodate safety testing of battery modules used in energy storage systems and automotive battery packs. Both burn facilities are instrumented for thermal, flow, and gas characterization. Cycling and conditioning facilities are available for modules up to 100V at 60 A.

Image of UTFRG's 16 x 20 ft burn structure and detached data acquisition room (*top*). Images of large-scale burns conducted in the burn structure (*bottom*).

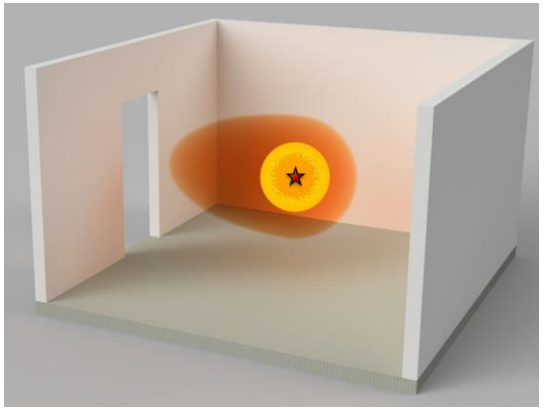
Thermal Runaway, Fire, and Explosion Modeling

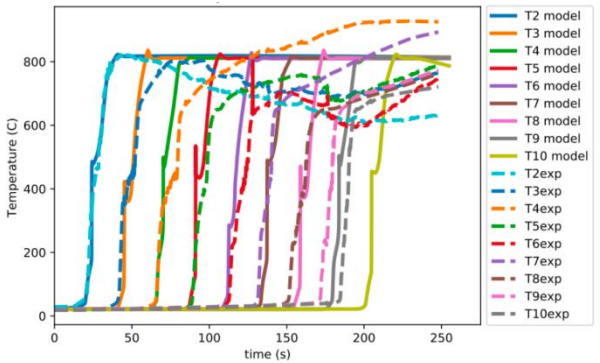
Thermal runaway and explosion testing of large battery systems can be prohibitively expensive as larger battery systems can range from tens of thousands of dollars for automotive battery packs to hundreds of thousands of dollars for energy storage battery racks. Fire and explosion modeling is a valuable tool that complements safety testing and reduces the overall cost of safety evaluation programs. Li-ion battery fire and explosion phenomena are multi-physics problems that require a suite of modeling tools to characterize them. UTFRG has developed and validated several in-house modeling codes and open-source software suites to assess Li-ion battery safety.



The rate of thermal runaway dictates the gas generation rate and the cascade for a battery system to generate hazardous conditions in enclosures and compartments. Using measured cell properties, kinetics are developed for cell-to-cell propagation and gas venting rates. These results are then used for design of explosion mitigation strategies, such as deflagration vents.

Explosion mitigation requires characterization of battery gas evolution and properties. Cell specific gas properties are measured and used as inputs in combustion and explosion dynamics codes.





QUESTIONS?

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