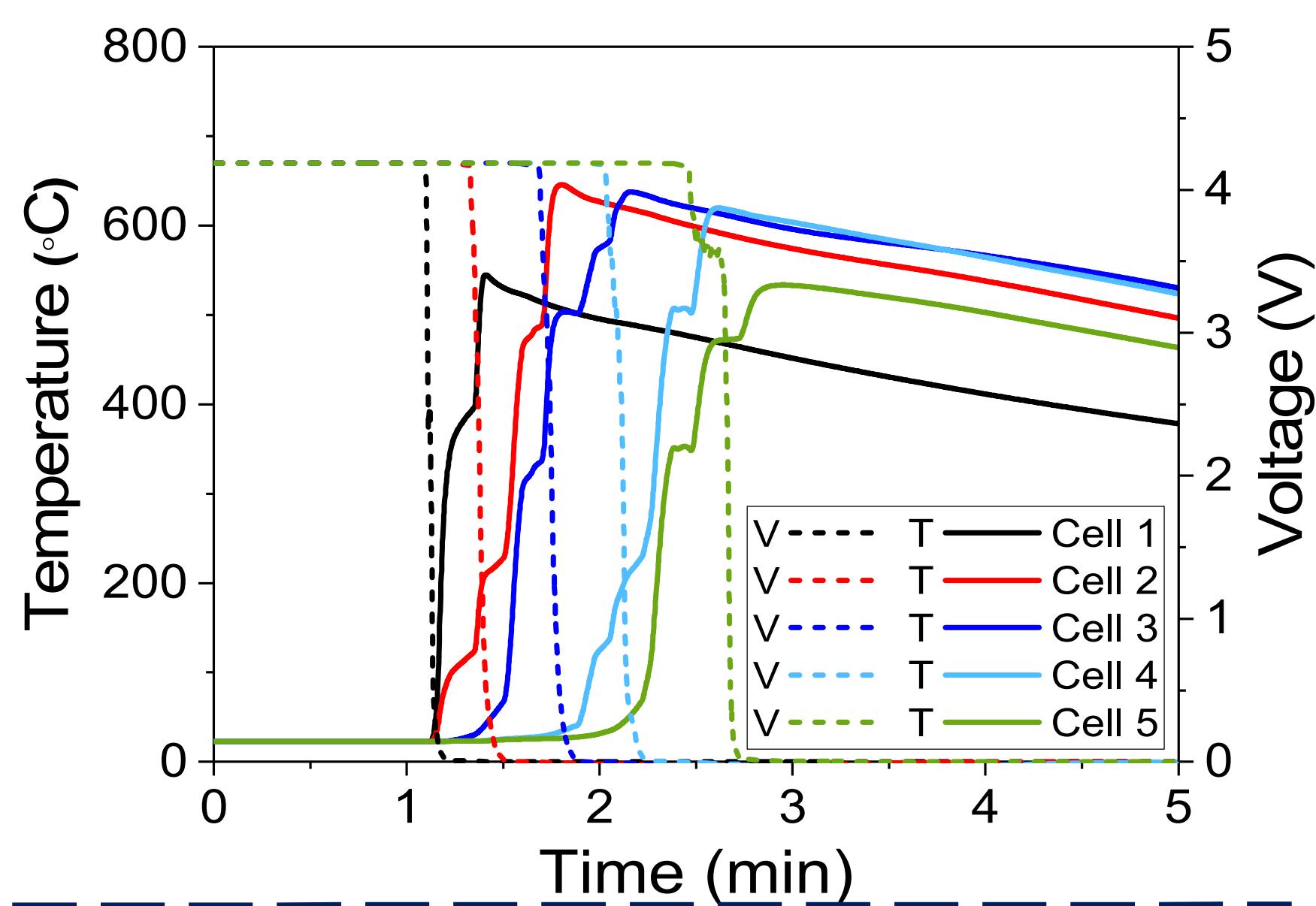
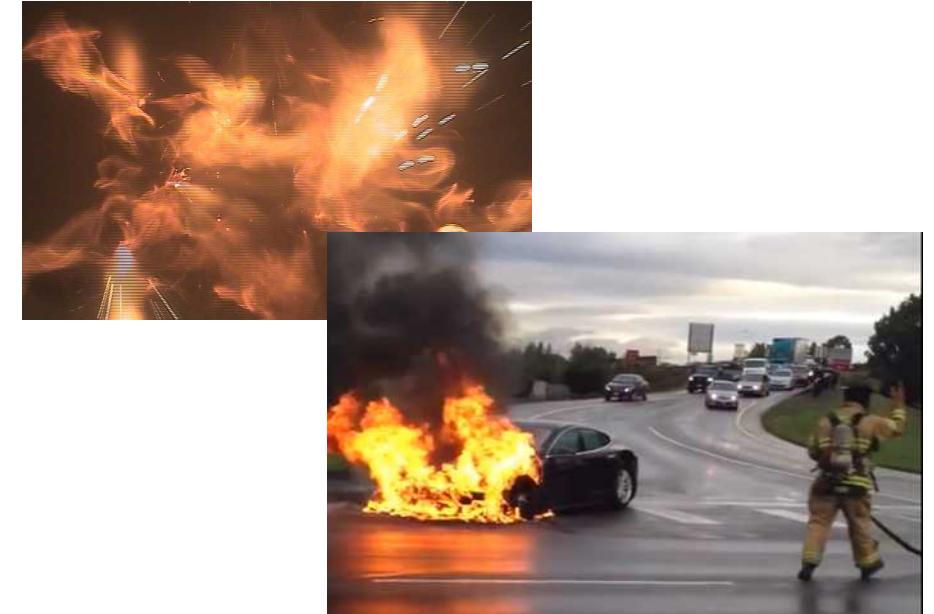
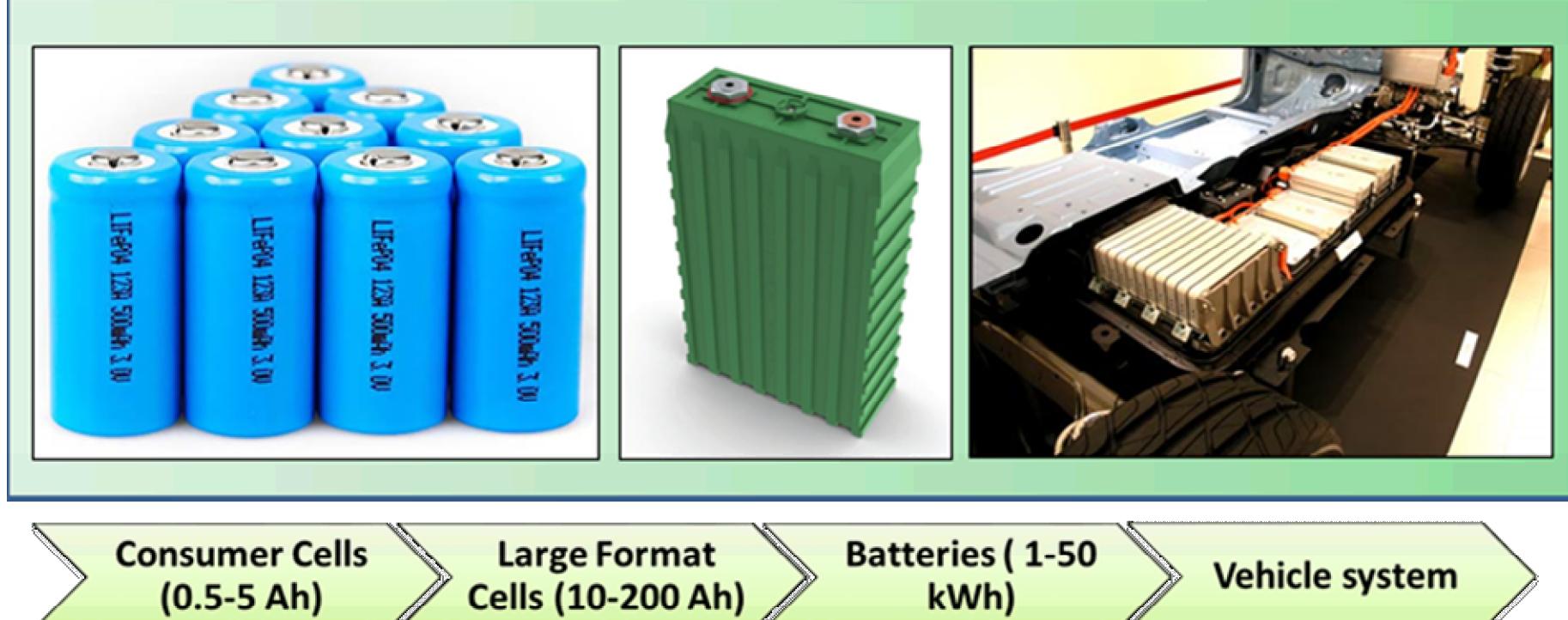


# Comparison of Propagation Mitigation Techniques and Strategies

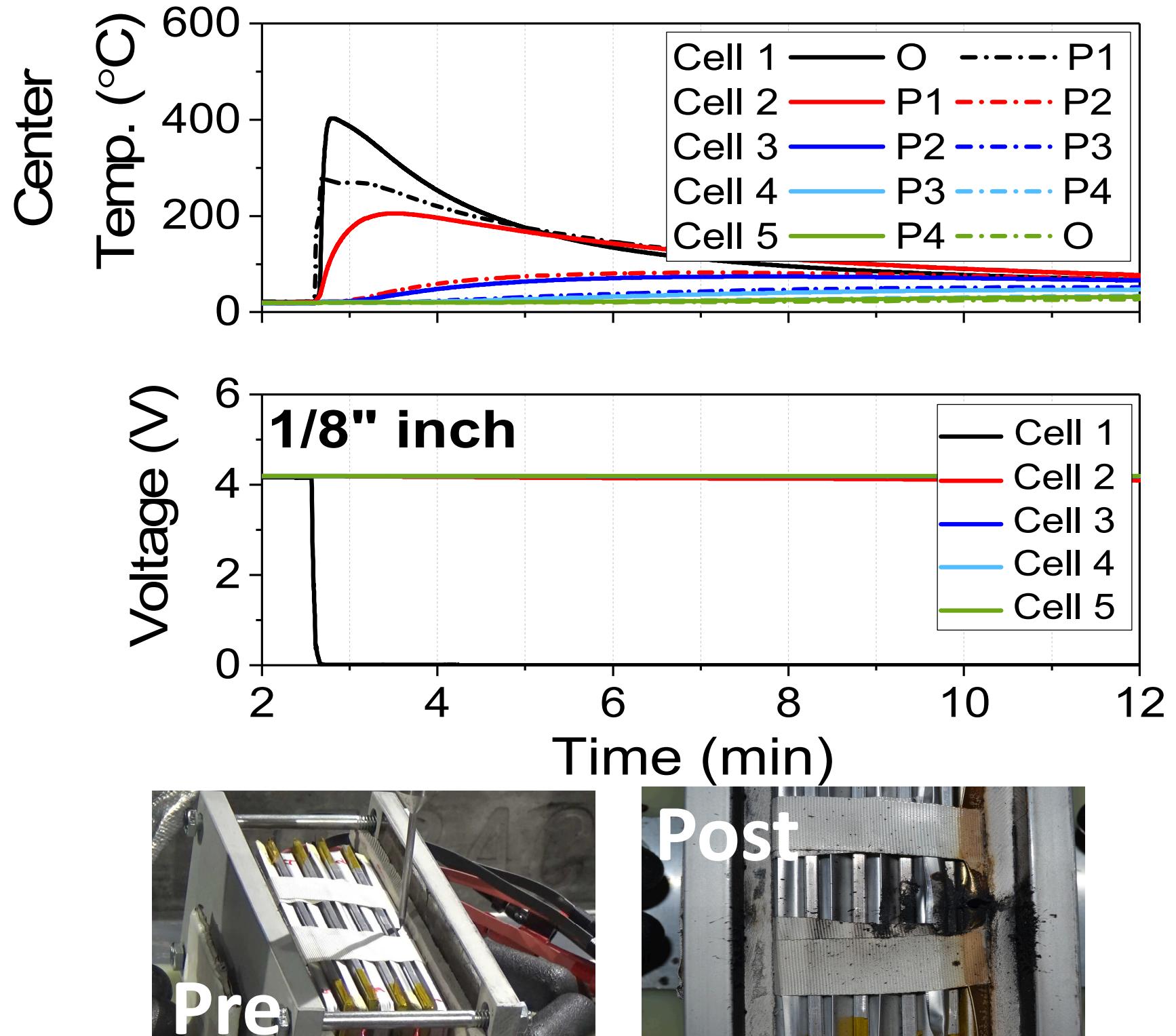
Lorraine Torres-Castro, Joshua Lamb, Leigh Anna Steele, Jerry Quintana, Christopher Grosso and June Stanley

## Introduction

- Safety of LIB has long focused on the impact and aftermath of a single cell failure.
- Failure of a single cell (inside a pack) may solely have little impact on the safety of the system. However, the thermal and electrical impact on other cells in the pack may be sufficient to cause a cascading runaway effect.
- Work presented here examines the failure propagation behavior of small battery modules constructed with stacked pouch cells and the development of propagation mitigation techniques and strategies.



\* The same set of tests were performed using Cu spacers



- Successful initiation at Cell #1 for all the different tests.
- While utilizing 1/8" inch Al or Cu spacers, no propagation was realized.
- Limited propagation (from Cell 1 to Cell 2) occurred with 1/16" inch Al and Cu spacers. However, the voltage drop of the pack using Cu spacers was significantly slower.

- As the size and complexity of battery packs increases, single cell failures within a pack become significantly more likely – this work looks at the mechanisms of how a single cell failure might impact a larger battery, as well as how it might be mitigated.
- Unmitigated fully charged pouch cells saw a complete consumption of the packs tested.

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## Methodology

### Part I: Baseline Failure Propagation

LCO 3Ah cells closely pack together (5 cells)



Pack is setup at 100% SOC



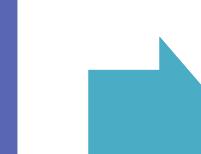
Failure initiated by a mechanical nail penetration

### Part II: Inactive Thermal Management

LCO 3Ah cells closely pack together with Al or Cu plates between them (5 cells)



Pack is setup at 100% SOC



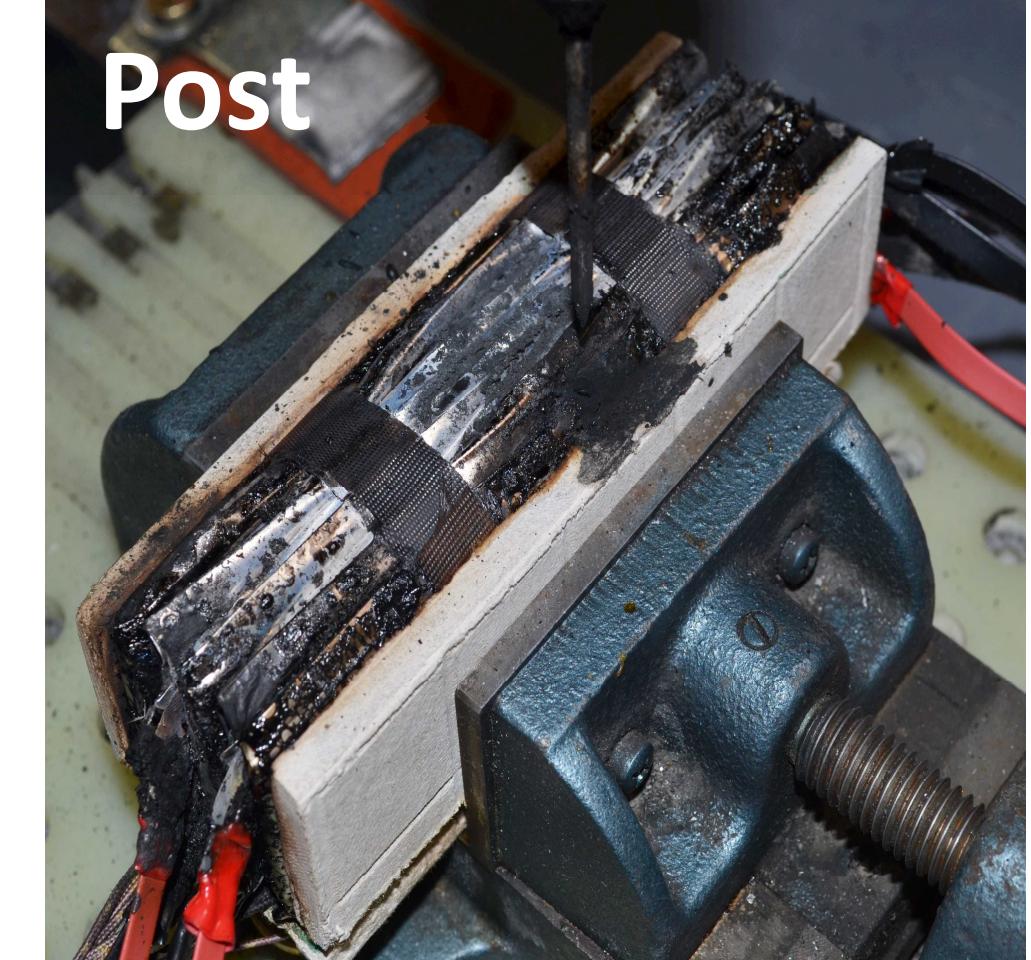
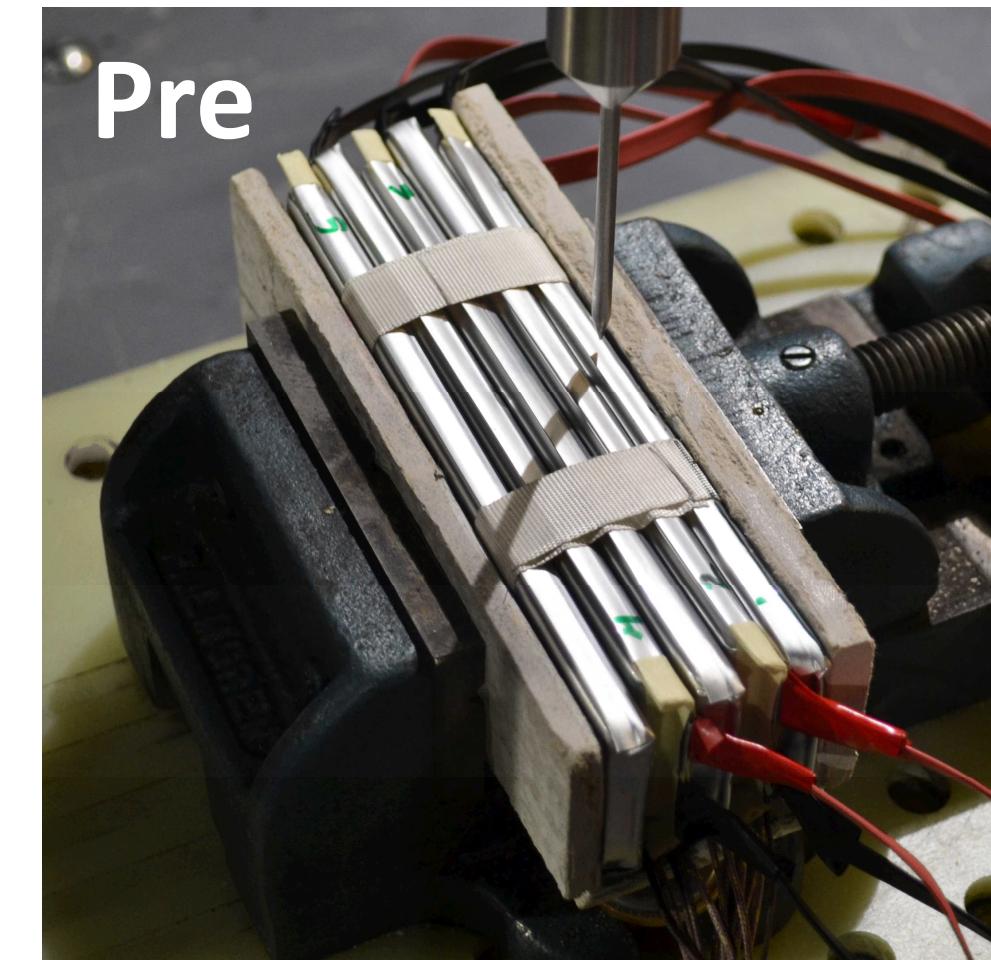
Failure initiated by a mechanical nail penetration

## Part I: Baseline Failure Propagation

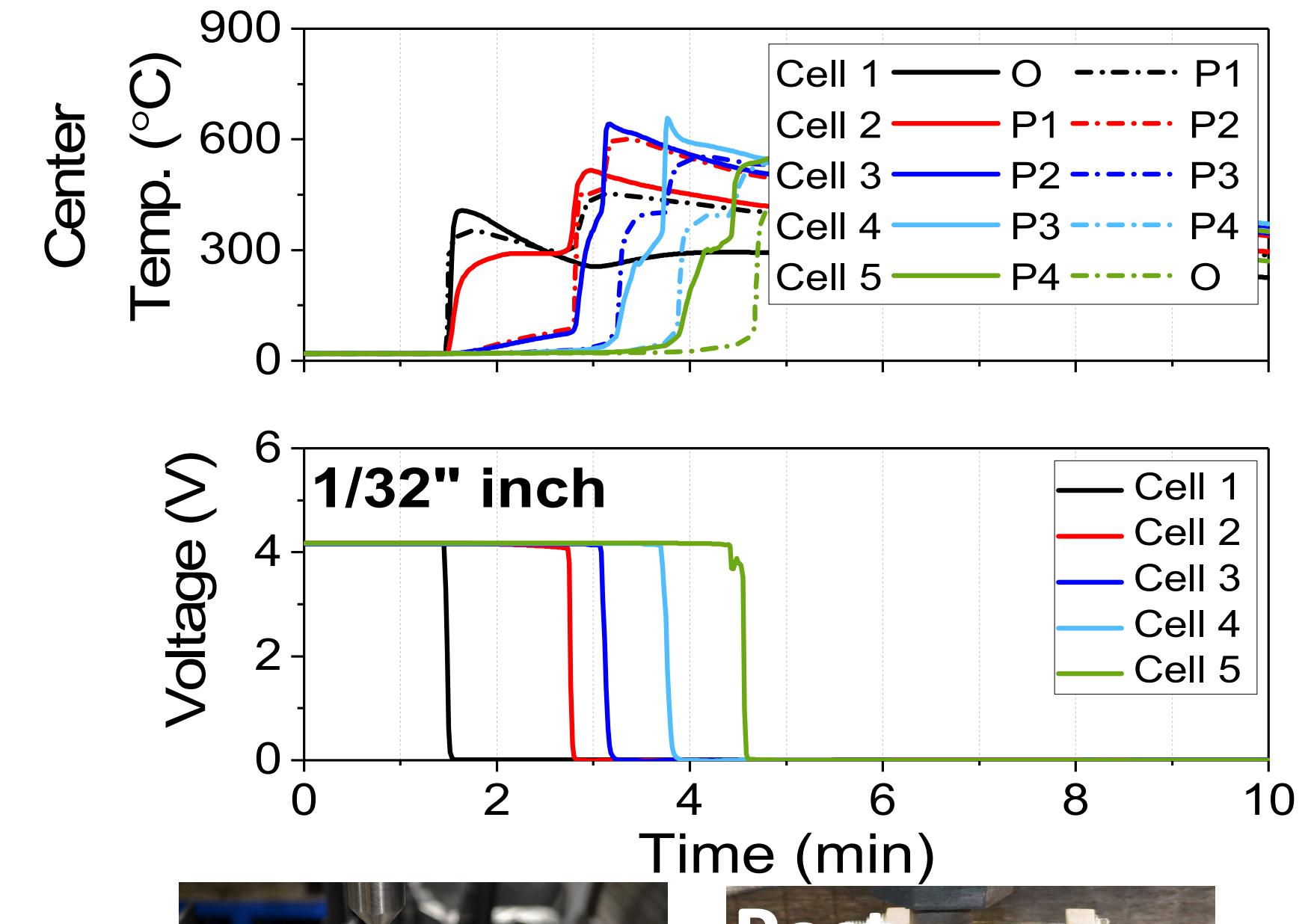
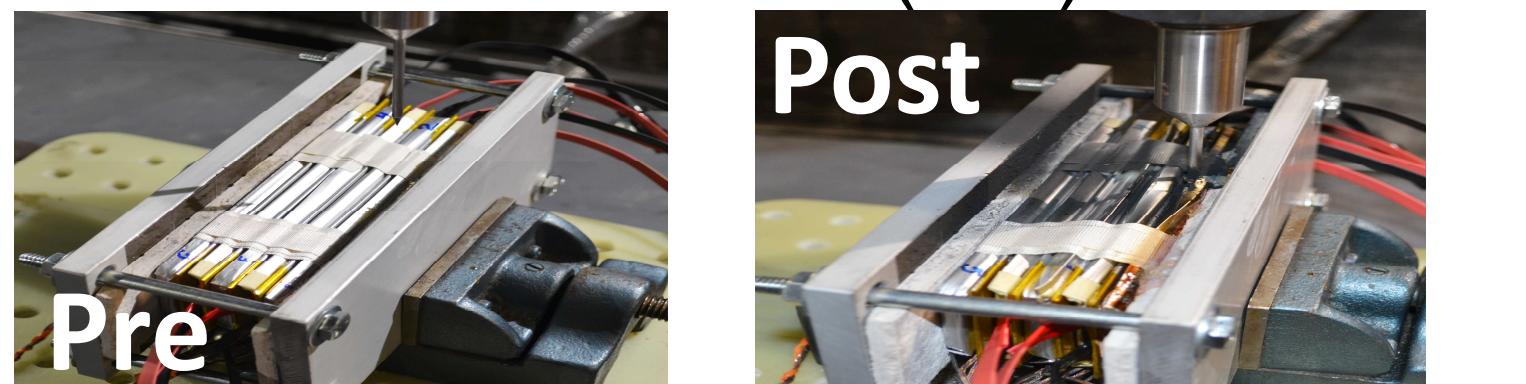
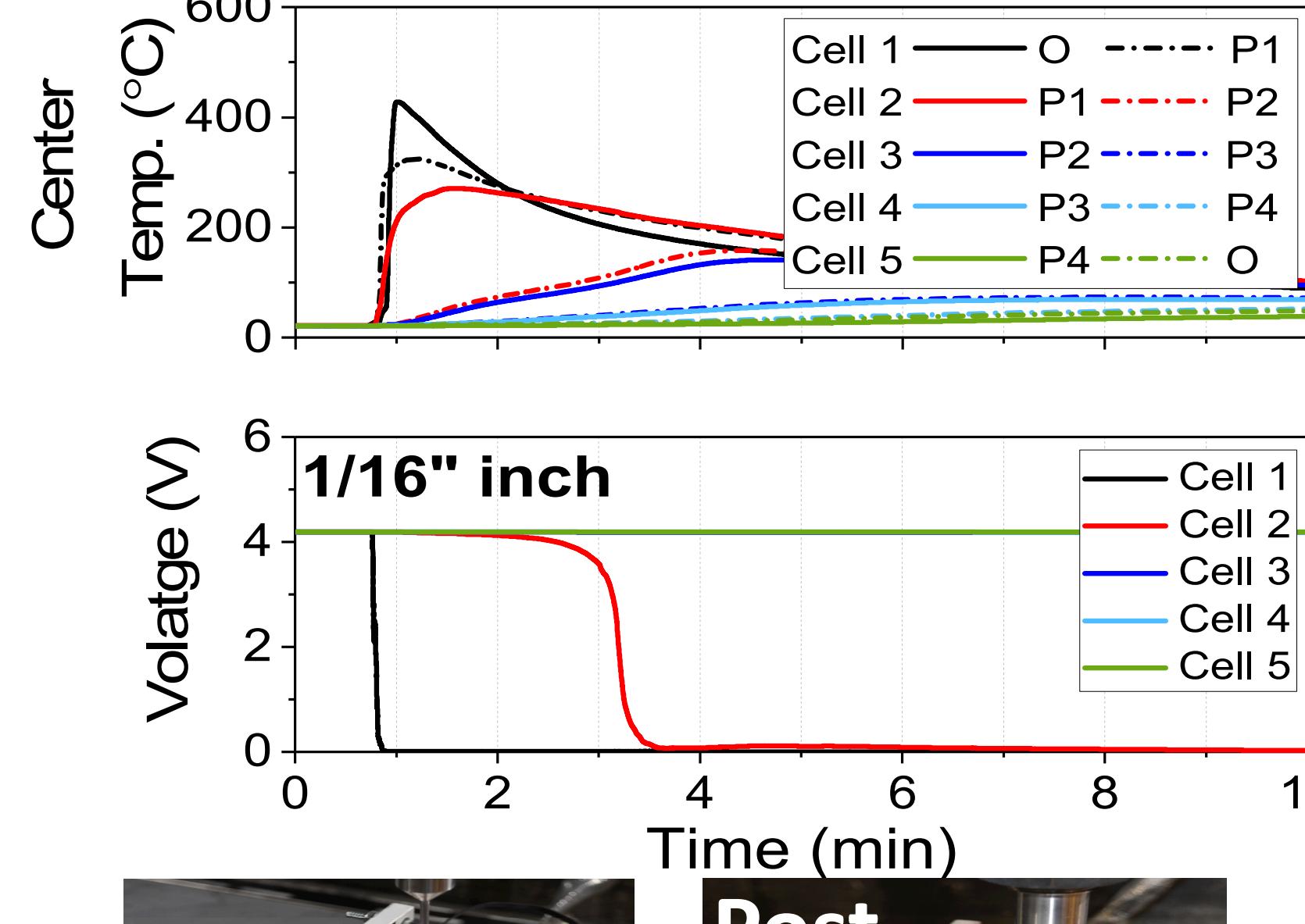
### Cell Specifications

Cathode	LCO
Capacity	3 Ah
Nominal Voltage	3.7 V
Max Discharge Current	10C

- Successful initiation at Cell #1.
- Propagation to adjacent cells.
- Cascading failure to entire battery over 82s.



## Part II: Thermal Management (Al spacers)\*



- Cascading failure to the entire battery for the thinner material (1/32" inch Cu or Al). Full propagation was realized after 172s and 188s for the packs using Al and Cu spacers, respectively.

## Summary

- Al and Cu barriers were used as a means of passive thermal management to slow or halt thermal runaway propagation between cells.
- 1/16" plates limited propagation to a single cell, while 1/8" plates arrested it altogether.
- 1/32" plates did not halt propagating battery failure, but did increase the time for full consumption of the pack by 5:1