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Concept Integration and Scale Up for Demonstrating Li-S

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Motivation

- As JCESR moves into its final year much effort will be placed into developing a LiS based prototype for transportation.
- There have been many technologies developed in JCESR however, it is currently unknown how these technologies will work when they are all combined into a single platform.
- Using a materials based approach that enables cost reduction by adding less electrolyte and when coupled with a protected metal anode affords increased safety, cycle life, and energy density
- **Our target Li/S electrode stack at the end of 2017 will have the following properties and demonstrate 100+ cycles before 20% capacity fade:**

Approach

Long Cycle Life High Areal Capacity Cathode

Designer Electrolytes and Cathode Design

Protected Lithium Metal

Combine these technologies into a single platform. **The goal is to drive energy density up and cost down**

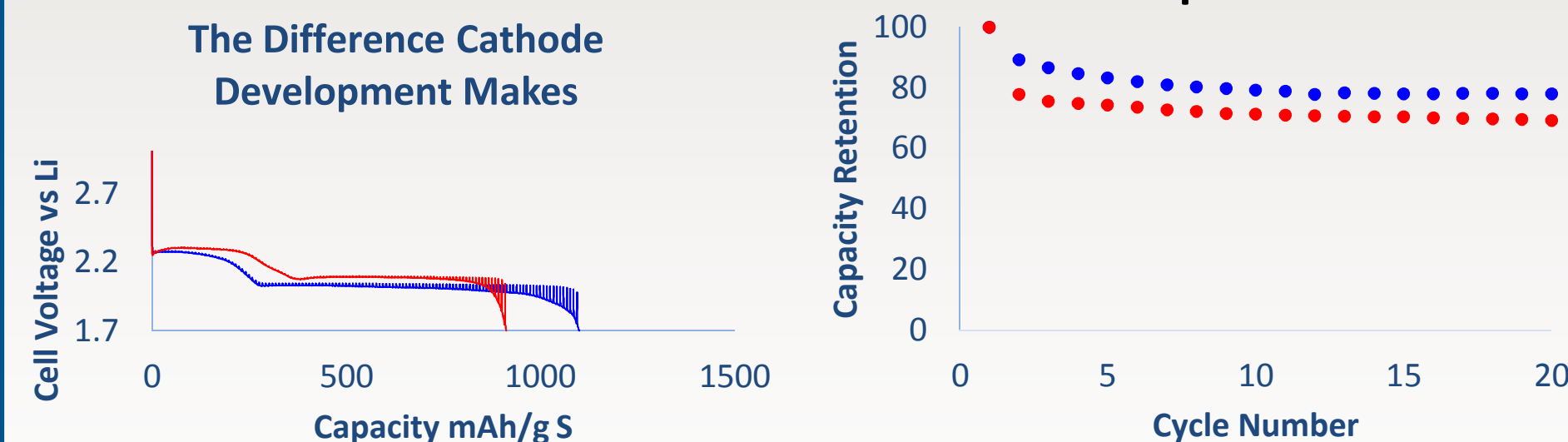


Prototype that is **\$100/kWh and 400Wh/L and 400Wh/kg**

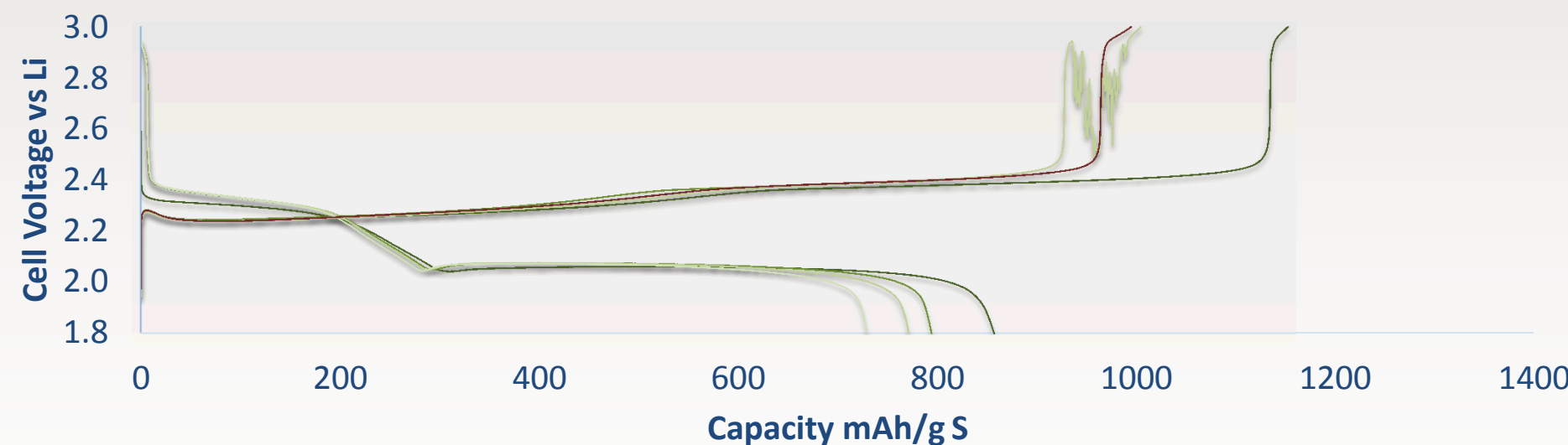
Major Accomplishments

Multifunctional Binder Development

The Difference Cathode Development Makes

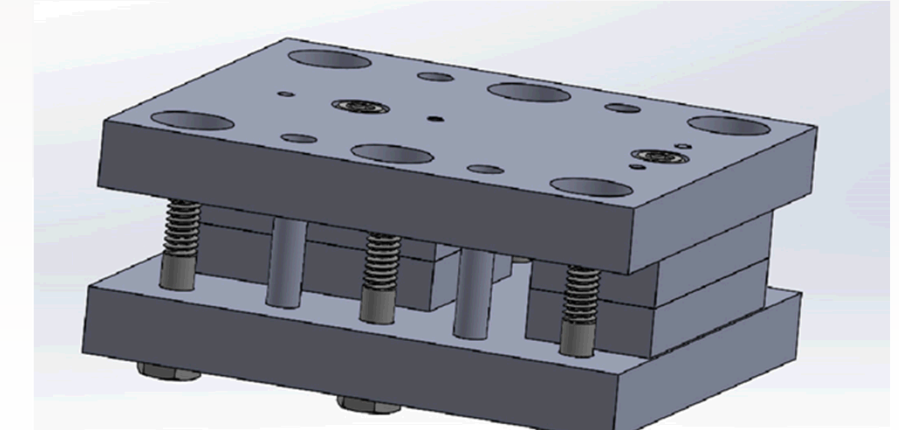


Multifunctional Binder with Designer Electrolytes

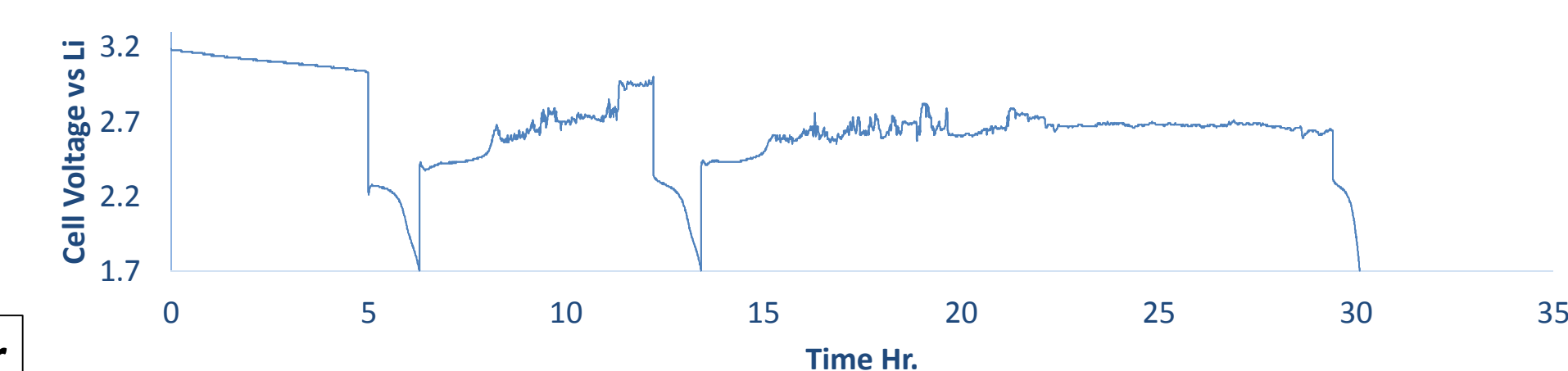


Li Metal Protection with Compression

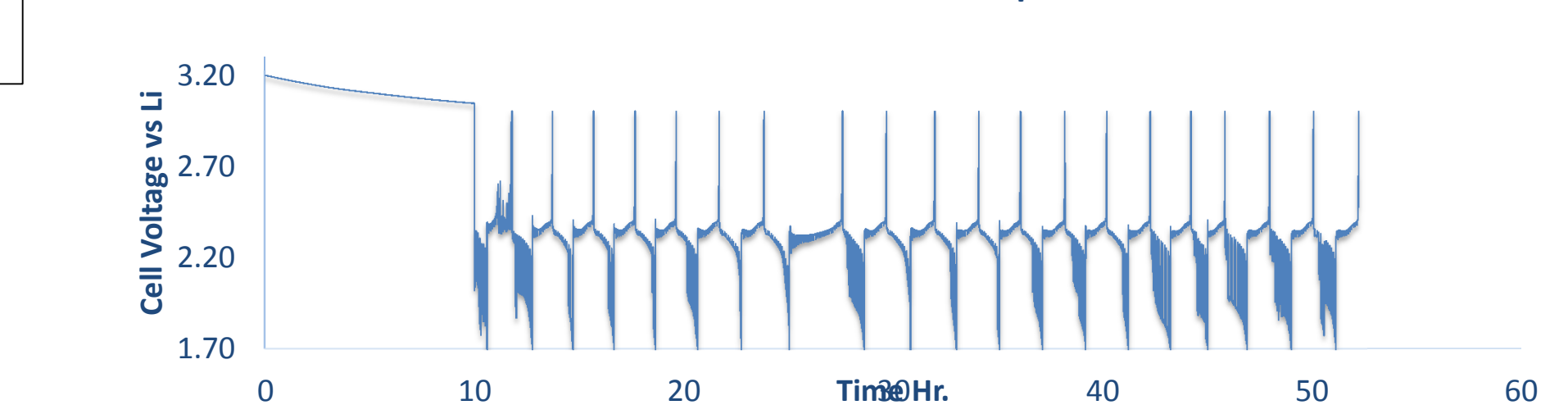
Exceeding the yield strength of Li can suppress dendrites. Thus **compression** can be used as an **effective Li anode protection scheme**. This increases the **coulombic efficiency** of the cell resulting in **increased cycle life and safety**. To exceed the yield strength of Li in a pouch cell a special jig was designed to provide uniform compression in our cell format.



1Ahr Pouch Cell under High Compression at 2ml/g



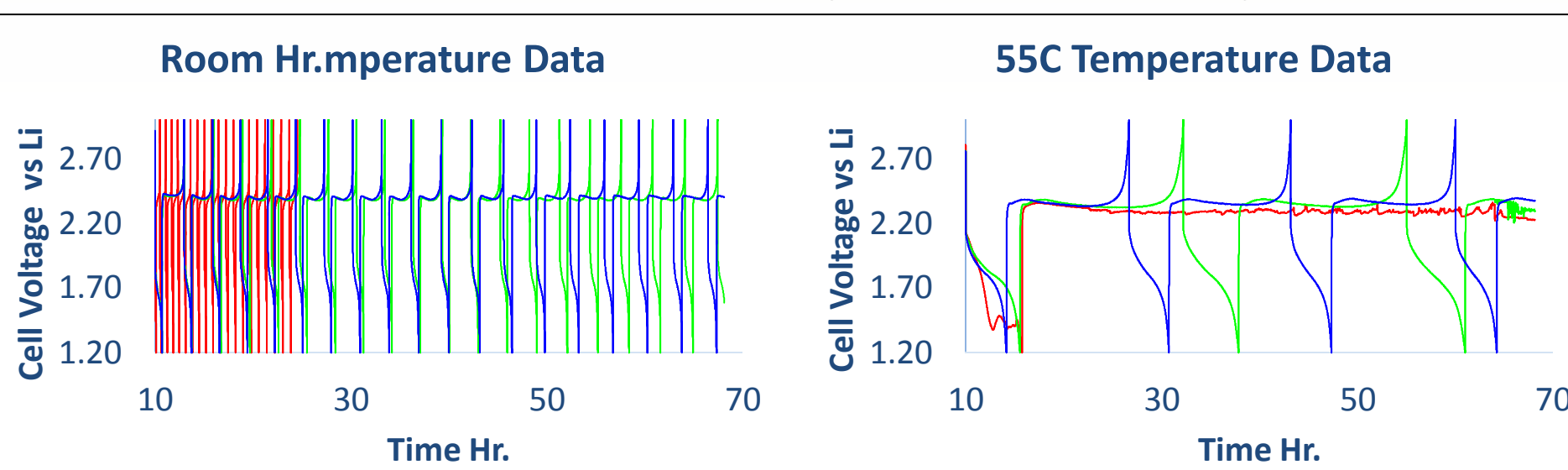
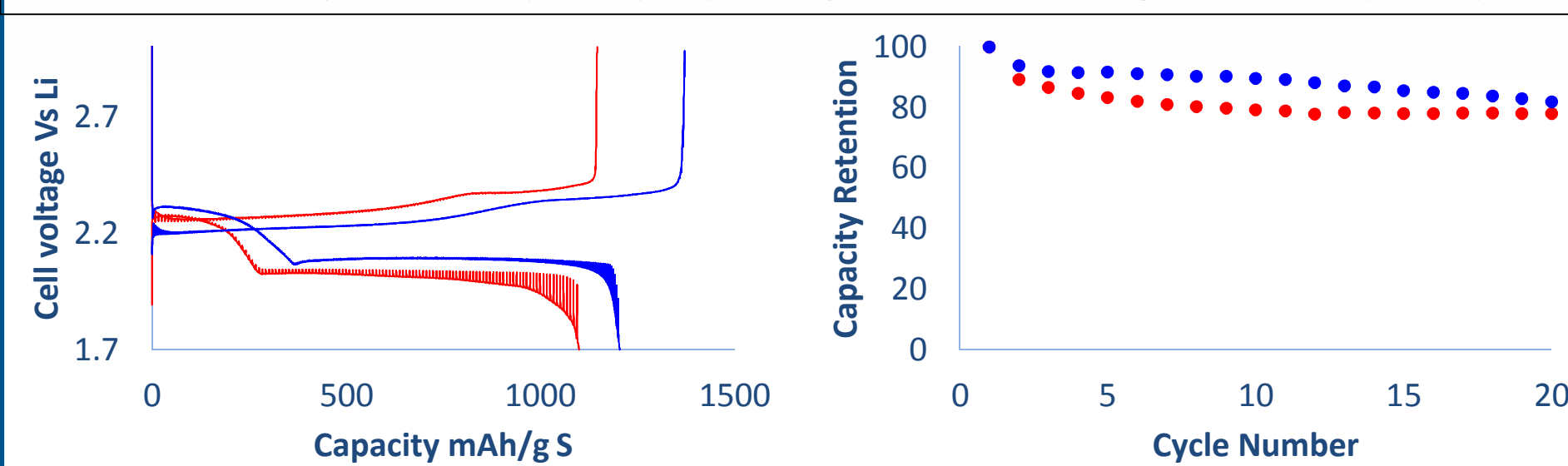
Multifunctional Cathode Over compressed



Cell looks like it devolved a short short currently investigating. Too much compression will hinder cell performance.

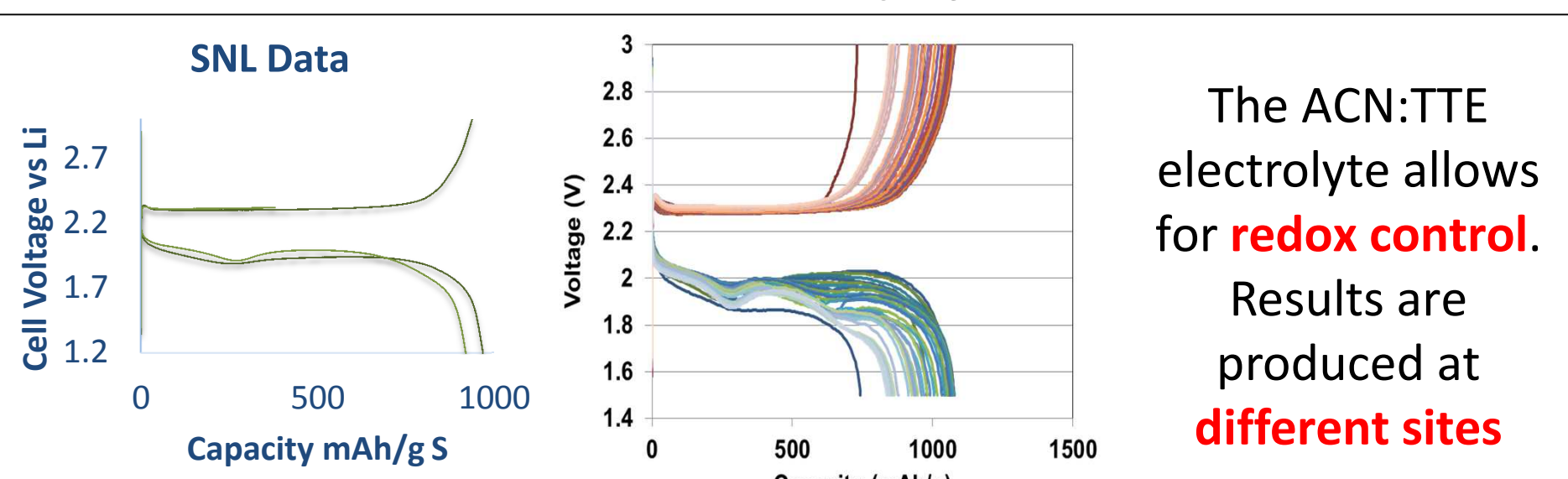
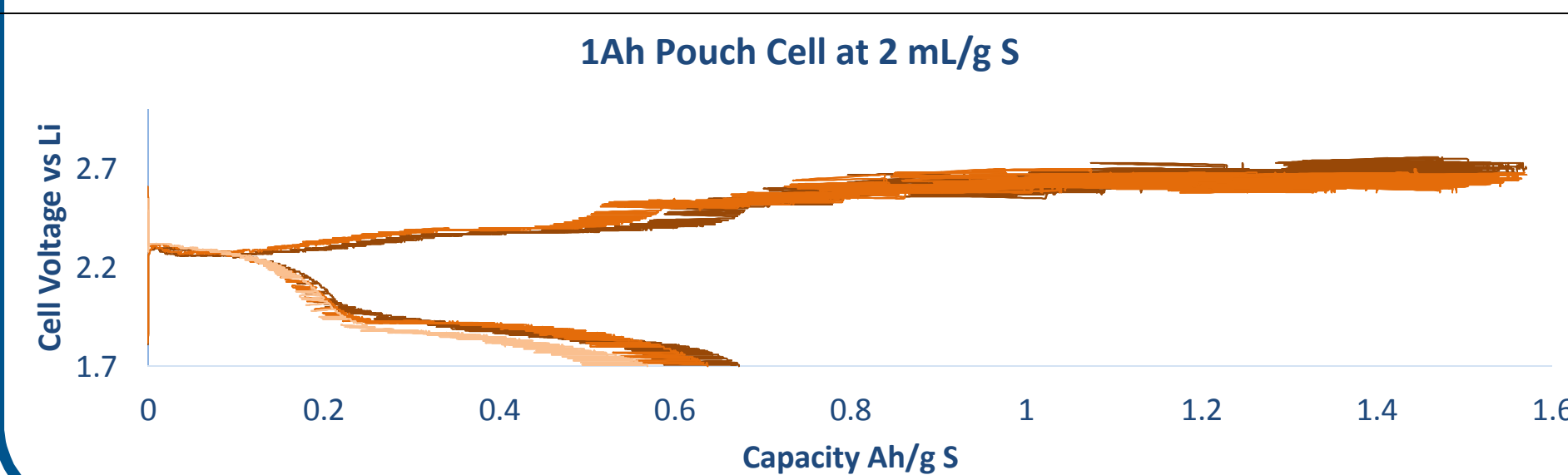
Utilizing what we learned from the development of **Generation 1** cathode a new cathode was developed. The **PEO based multifunctional cathode** improves **capacity, cycle life, and loading (areal capacity)**

By combining a multifunctional binder and a **redox mediator** electrolyte, we aim to **control parasitic reactions** as a strategy to extend cycle life. This combined with lean electrolyte condition is very effective



Through much effort the transition was made from **coin** to **pouch**. By lowering the amount of electrolyte added to the cell it is discovered that **the cost goes down and the cyclability goes up**

By **modifying** the benchmark electrolyte with a **highly fluorinated ether (1:1 1:2 1:3)** and multifunctional binder the **polysulfide solubility can be tuned to enhance the performance**.

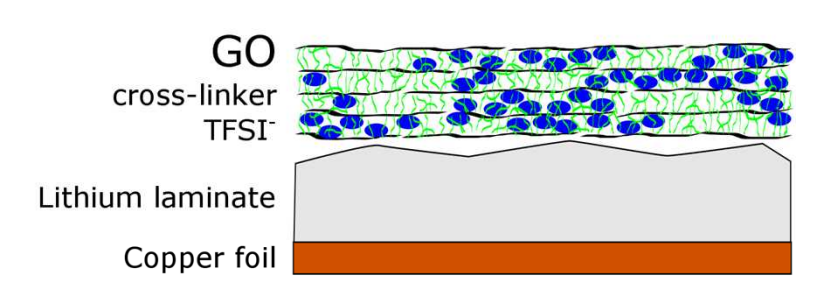
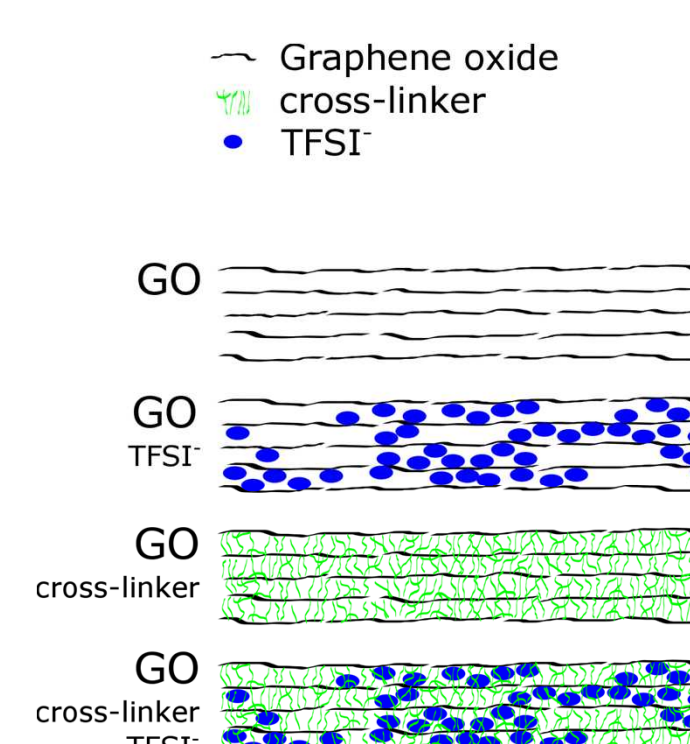
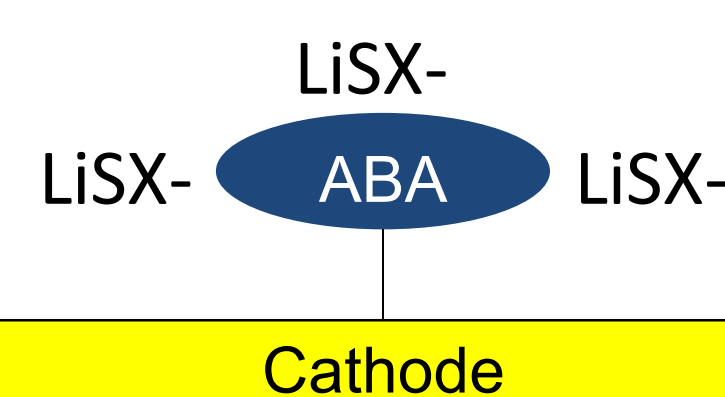


The ACN:TTE electrolyte allows for **redox control**. Results are produced at **different sites**

Future Directions and Impact

- Strategies like multifunctional binders and designer electrolytes are being used to suppress and control the polysulfide discharge products.
- Can we design a molecule that can be incorporated into the cathode that prevents polysulfide diffusion improving capacity retention and shutting down the shuttle mechanism?

Anion Binding Agent Concept



Li metal anode protection is critical for reaching JCESRs goals

Outlined to the left is a cartoon of a graphene oxide protection scheme

This process is currently being incorporated into cells with multifunctional binder and designer electrolyte

Key Take-Away

- Testing new materials and evaluating the benefits of integrations across multiple scales
- Achieved 2mL/g electrolyte which is well on the way to a 50%vol fraction
- Platform integration allows for large scale testing enabling the reduction the electrolyte volume fraction

