In-Operando Thermal Diagnostics of Electrochemical Cells

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

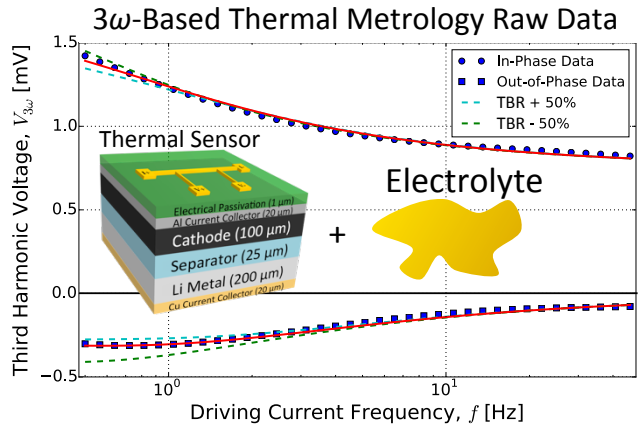
PI/Co-PI: Ravi Prasher (LBL) / Vince Battaglia (LBL)

Objective: Develop and apply a metrology to measure *in-operando* temperatures and thermal transport property depth profiles within an electrochemical cell under various operating conditions

Impact:

- Provide crucial insights on thermal transport within batteries in different operating conditions
- Enable these diagnostic capabilities for industry and other research labs. Additionally, such insights could:
  - Enable faster charge/discharge of battery
  - Improve safety vs. thermal runaway phenomena
  - Improve battery lifetime reliability
  - Reduce required external battery cooling power

In-Situ Cathode-Separator Half Cell Thermal Boundary Resistance (TBR) Measurement



Fitted $TBR_{cath\text{-}sep}$ = **10.4 cm²-C/W**

Accomplishments:

- First *in-situ* measurement of cathode-separator thermal boundary resistance (*TBR* = 10.4 cm²-C/W) in fully-functional Li-ion cathode half cell. Verified as primary heat transfer bottleneck.
- Development of metrology and novel data analysis technique capable of required thermal measurements
- Numerical optimization of sample design to maximize measurement sensitivity and minimize noise from environment

FY18 Milestones:

- Fabricate full battery pouch cell with sensors
- Perform *in-operando* TBR measurements of full Li-ion battery cell
- Measure TBR as a function of externally applied pressure

FY18 Deliverables: Full Li-ion battery pouch cell fabricated with sensors having measured *in-operando* cathode-separator TBR

Funding: FY18: 150k, FY17: 150k, FY16: 150k

Project Title

U.S. DEPARTMENT OF **ENERGY**
Energy Efficiency & Renewable Energy

PI/Co-PI: PI Name (Affiliation)/ Co-PI Name (Affiliation) / Co-PI Name (Affiliation)

- ***Objective:***
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  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
  XXXX ***THE OBJECTIVE SHOULD COVER THE ENTIRE LENGTH OF THE PROJECT.***

Impact:
- XXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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EXPLAIN THE PROJECT'S UNIQUENESS? DESCRIBE HOW THE EFFORT WILL IMPROVE BATTERIES FOR ELECTRIC VEHICLES.

Title of Graph/Concept

SHOW GRAPHIC DEMONSTRATING YOUR <u>LATEST</u> ACCOMPLISHMENTS <u>OR</u> IN THE CASE OF A NEW START, SHOW THE CONCEPT OF THE EFFORT.

Accomplishments: ***LIST THE PROJECT'S TOP ACCOMPLISHMENTS TO DATE. IF THIS IS A NEW PROJECT, STATE "NEW START".***
- XXXXXX XXXX
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FY 18 Milestones:
- XXXXXXXXXXXXX
- XXXXXXXXXX
- XXXXXXXXXXXXXXX
- XXXXXXXXXXXXX

DESCRIBE SIGNIFICANT MILESTONES FOR FY17.

FY18 Deliverables:
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxx ***LIST THE EXPECTED PROJECT DELIVERABLES FOR THIS FISCAL YEAR.***

Funding:
— FY18: ?, FY17: ?, FY16: ?

OVERCOMING INTERFACIAL IMPEDANCE IN SOLID-STATE BATTERIES

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

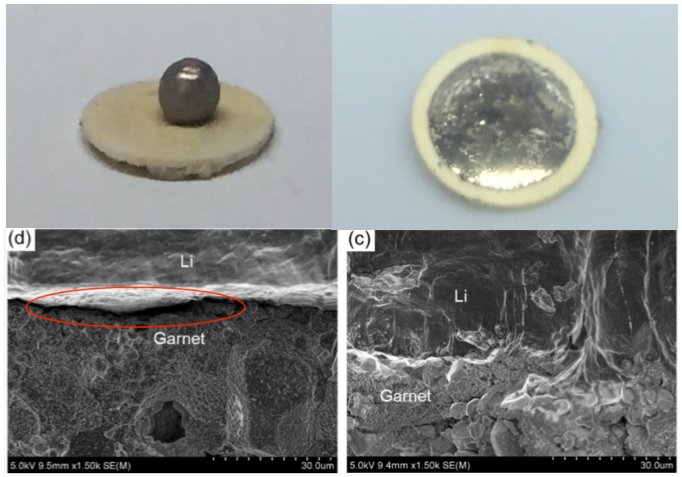
PI/Co-PI: Eric Wachsman (UMD)/ Liangbing Hu (UMD) / Yifei Mo (UMD)

Objective: Develop a multifaceted and integrated (experimental and computational) approach to reduce interfacial impedance of garnet-based solid-state Li ion batteries (SSLiBs).

Impact:

- Overcome primary issue with garnet electrolyte SSLiBs, interfacial impedance, thus enabling an entirely new safer (non-flammable) battery platform
- Enable highest capacity Li-metal anodes with no dendrites for higher energy density batteries (~500 Wh/kg)

Li Metal Wetting of Solid-State Electrolyte



Developed surface treatment to allow Li-metal wetting thus dramatically reducing interfacial impedance

Accomplishments: (FY16)

- First comprehensive investigation of interface impedance in garnet based SSLiBs
- Determined interfacial impedance as function of electrolyte/electrode contact area in 3D controlled solid state structures
- Developed computational models to investigate interfacial ion transport with interlayers
- Developed multiple efficient interlayer solutions to decrease interfacial impedance
- Demonstrated low interfacial impedance (~10 Ω cm^2) between both electrolyte and Li-metal anode and between electrolyte and cathode

FY 17 Milestones:

- Demonstrate full cells with NMC cathode
- Demonstrate full cells with Sulfur cathode
- Develop models to investigate interfacial transport for Li-S and Li-NMC SSLiBs
- Achieve full cell (Li-S or Li-NMC) performance of 350-450 Wh/kg and 200 cycles

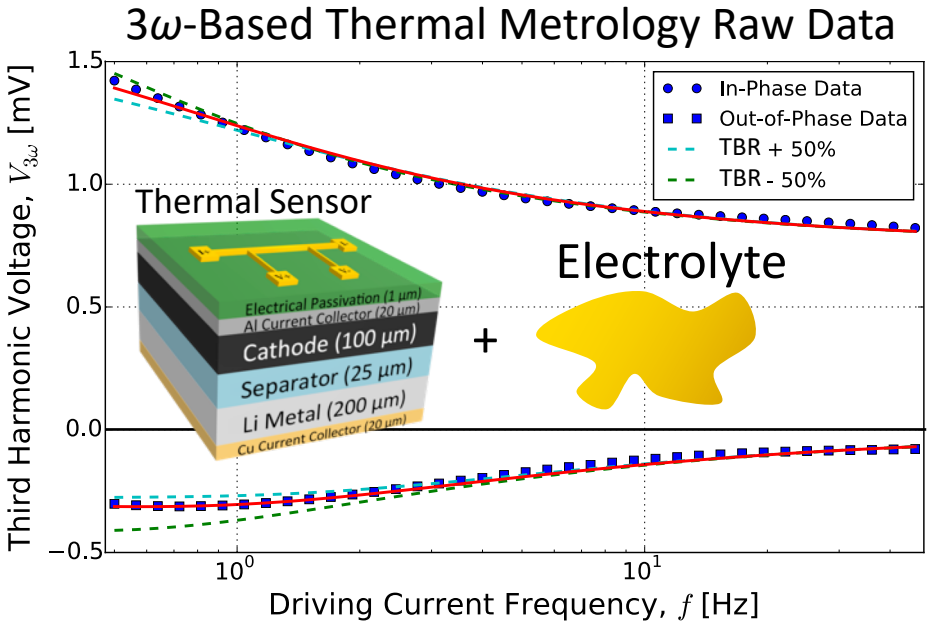
FY17 Deliverables: Submission of 12 improved cells for government testing and evaluation

Funding:

— FY17: $401,634, FY16: $401,635 FY15: $409,608

Slide with raw graphics (main quad chart has these graphics as single PDF files each)

Battery pouch cell powering LED during TBR measurement



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