

Thin-Film Lithium Metal Manufacture by Room Temperature Electrodeposition

DOE cost-shared project

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2021 Vehicle Technologies Annual Merit Review

Project ID: bat522

Overview

Timeline

- Start date: May 2020
- End date: May 2023
- Percent complete: **30%**

Budget

- Total Project Funding: \$5.4MM
- DOE: \$4.3MM (80%)
- Cost Share: \$1.1MM (20%)

Barriers

- Need stable membrane capable of exhibiting Li ion conductivity and low water crossover
- Need production of Li foil to be cost-effective

Relevance

Impact

- High-quality, low-cost Li metal anodes
- US leadership in manufacturing of advanced battery materials
- Enabler for increased domestic battery manufacturing

Objectives

- Dual-chamber electroplating from low-cost aqueous Li salt
- High efficiency, cost competitive roll-to-roll route to ultra thin Li metal anodes
- Process scale-up and validation in prototype system

Milestones (Budget Period 1)

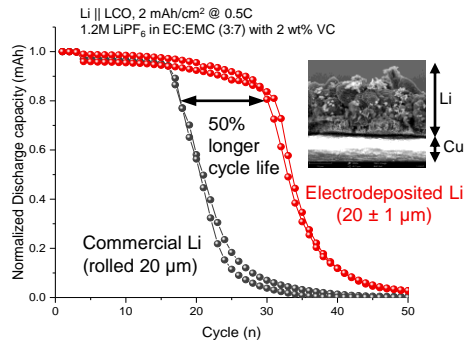
| Milestone | Type | Description | Status |
|---|-----------|--|-------------|
| Design and Construction of One-Compartment Electrolysis Cells | Technical | Construction of a lithium metal electrolysis cells capable of producing lithium plated areas | Complete |
| Performance Comparison | Technical | Quantitative performance comparison between electrodeposited thin film lithium and commercial lithium metal in coin and pouch cell testing | In Progress |
| Comparison of Two Compartment Electrodeposition | Technical | Quantitative comparison of lithium metal thin film using one and two compartment cells. Comparison will be conducted with coin and pouch cell testing. Confirm that model-predicted large volume production cost of 20 μ m Li anode by electrodeposition is less than half price of conventional foil. | In Progress |
| Go/No Go Decision (Achieve Performance Measures) | Go/No Go | Battery capacity retention is equal to or better than conventional foil after 50 cycles at C/5. | Complete |

Approach

- Electrolyte optimization in single compartment cell
 - Coin & pouch cell testing
- Design two-compartment cell & membrane development
 - Coin & pouch cell testing
- Design prototype unit
- Develop electrodeposition cost model
 - Assess cost effectiveness of electrodeposition method

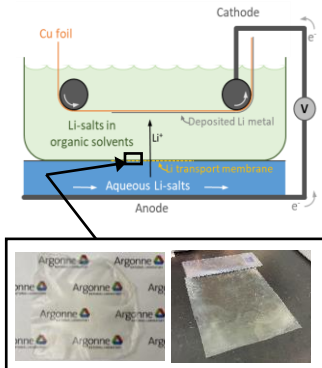
Technical Accomplishments and Progress

- ✓ **Demonstrated battery performance superior to rolled foil**



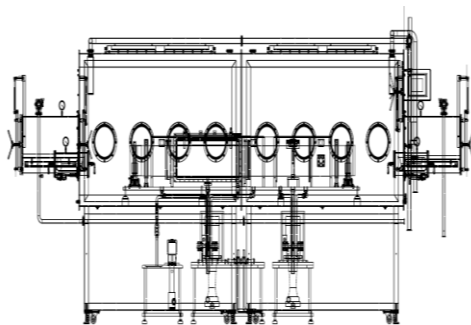
- Achieved ~50% longer cycle life to 80% capacity with electrodeposited Li anode

- ✓ **Improved membrane performance**



- Produced polymer membrane with high Li ion conductivity and significant reduction in anolyte, catholyte, and water crossover

- ✓ **Selected vendor & designed prototype electrodeposition unit**



- Collaborated with a vendor to design pilot scale prototype electrodeposition unit

Summary

- Electrodeposited anodes using one compartment cell show 50% longer cycle life at 80% discharge capacity retention when compared against rolled Li of same thickness
- Gen3 membrane shows high Li ion conductivity and significant reduction in water crossover

Remaining Challenges

- Scale membrane synthesis to meet prototype unit requirements
- Develop strategy for handling potential water crossover
- Demonstrate path to 5-20 μ m Li foil at Gigafactory scale
- Demonstrate uniform Li deposition in two-compartment electrolytic cell

Future Work

- Complete membrane development and fabrication
- Test coin & pouch cells with anodes made in two-compartment cells
- Acquire, install, debug and validate prototype unit
- Test coin & pouch cells with anodes made in prototype electrodeposition unit

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Any proposed future work is subject to change based on funding levels.