2010 DOE Vehicle Technologies Program Review

Long-Living Polymer Electrolytes

P.I. - Chris Janke

Presenter - Robert E. Norris

Oak Ridge National Laboratory

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Project ID: ES094

Overview

Timeline

- Start – Jan 2010
- Finish – Dec 2010
- 20% Complete

Budget

- Total project funding
  - DOE - $300K

Barriers

- Barriers
  - Low cycle life
  - Low power
- Targets
  - Cycle life - 1000 cycles at 80% depth of discharge (DOD)

Objective

- Lithium metal batteries are plagued by short lifetimes that have prevented their application in hybrid electric vehicles
- The short lifetime results from roughening of and lithium dendrite growth on the lithium surface. This dendrite punctures the separator or polymer electrolyte and creates an internal short.

- **The objective is to significantly harden the PEO surface to prevent dendrite growth with no or little effect on lithium ion mobility, hence no or little performance reduction. The problem of current technology is that once you harden PEO to acceptable levels, it loses its conductivity.**

Milestones

Month/Year	Milestone
• May 2010	Process 1st set of PEO/Li salt samples
• June 2010	Evaluate ionic conductivity on selected PEO/Li salt samples. This provides information regarding the relationship between key processing parameters and ionic conductivity
• Sept 2010	Evaluate ionic conductivity, dendritic growth and interfacial impedance on 1st set of PEO/Li salt samples
• Dec 2010	Process 2nd set of PEO/Li salt samples

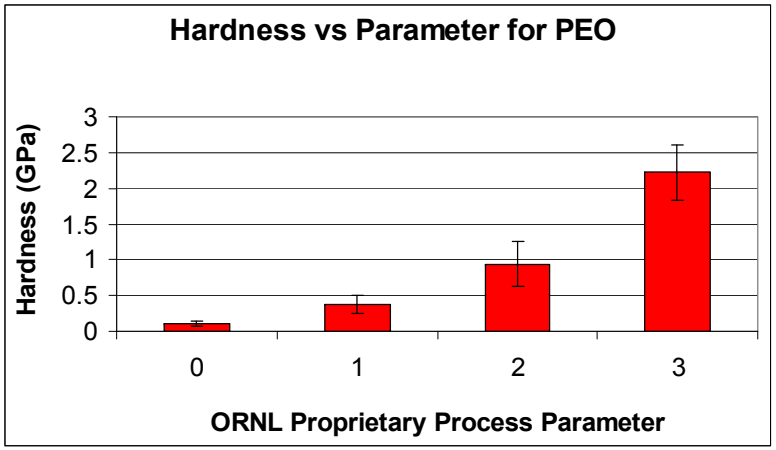
General Approach

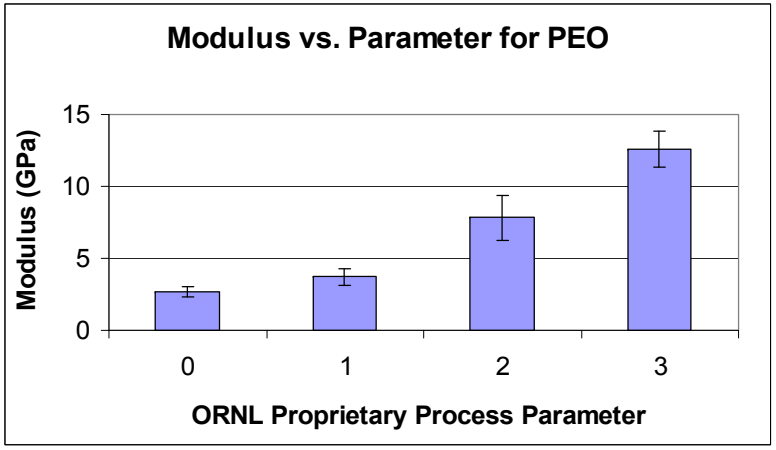
- Increasing the hardness/modulus of polymer electrolytes is a widely proposed method to prevent dendrite growth and the resultant anode-cathode short-circuiting in lithium metal batteries

- The approach is to employ a novel proprietary process developed by ORNL to increase the solid polymer electrolyte's hardness/modulus in a thin surface layer
- Evaluate the effect on ionic conductivity, dendrite growth and interfacial impedance
- Iterate the process to determine the optimum processing/material parameters that produce the best combination of hardness/modulus and ionic conductivity

Technical Accomplishments

- ORNL recently developed a proprietary process that can surface harden solid PEO electrolytes
- Solid PEO films using this process experienced over 20X increase in hardness and 5X increase in modulus compared to baseline PEO





Technical Accomplishments (Continued)

- Three PEO materials having different molecular weights have been obtained from manufacturer
- Finalized subcontract with facility for processing PEO materials
- Fabricated preliminary set of PEO film samples incorporating lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) salt
- Processed several PEO/Li salt film samples using proprietary process over a wide range of parameters
- Fabricated 1st set of PEO/Li salt film samples
- Finalized experimental test matrix for processing 1st set of solid, solvent cast PEO/Li salt film samples
- Prepared custom made Swagelok cells for ionic conductivity measurements on processed PEO/Li salt film samples

Activities for Next Fiscal Year

- Continue to iterate the process to determine the optimum processing/material parameters that produce the best combination of hardness/modulus and ionic conductivity
- Process the 2nd set of PEO/Li salt samples and evaluate the effect on ionic conductivity, dendrite growth and interfacial impedance

Summary

- Lithium metal batteries are of great interest for plug-in hybrid electric vehicles due to their low weight and minimization of inactive material, non-flammability, and high voltage stability
  - However, they are plagued by short lifetimes that have prevented their application in hybrid electric vehicles
  - The short lifetime results from roughening of and lithium dendrite growth on the lithium surface. This dendrite punctures the separator or polymer electrolyte and creates an internal short.
- Hardening of polymer electrolytes is a widely proposed method to prevent dendrite growth and the resultant anode-cathode short-circuit in lithium metal batteries
- ORNL has discovered a novel, tunable process that can make a very thin layer on the polymer surface harder than steel
- This process is currently being investigated on solid polymer electrolytes as a means for preventing dendrite growth in order to increase the lifetime of lithium metal batteries