Rate and solvent dependent mechanical properties of battery separators

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Abstract

A battery separator is a porous membrane that creates a physical barrier between electrodes. Our previous work shows compressive deformation of the separator can lead to increased impedance and capacity fade. Thus, knowledge of mechanical properties of separators are important for predicting long-term battery performances.

This poster presents compressive mechanical testing results under various loading rates and under a number of fluid environments.

Experimental

- Celgard 3501 microporous polypropylene separators, 0.375 inches in diameter
- 32 layers with 25 μm per layer
- Strain rates vary from $10^{-6}$ s$^{-1}$ to 1 s$^{-1}$
- Fluid environments: Water, DMC, 1 M LiPF$_6$ EC/DMC(1:1)

Results

- Flow stress and eff. modulus are defined to characterize the mechanical properties.

  Role of fluids under compressive testing

  - Effective Modulus
  - Flow Stress

  There is a rate dependence due to viscoelasticity and poroelasticity. The material becomes stiffer at a higher strain rate.

Conclusion

The compressive stress-strain behaviors of a microporous separator are characterized. The results show two important mechanical phenomenon during battery operation: a reduction in mechanical properties due to swelling of the polymer material, and the rate-dependence due to viscoelasticity and poroelastic phenomena arising from fluid ejection from the pores during compression.

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