Producing printable LiPON based solid-state electrolyte thin film using open-air processing

Daniel Hur, Electrical Engineering
Mentor: Dr. Nicholas Rolston, Assistant Professor
School of Electrical, Computer and Energy Engineering

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Introduction

Traditional Lithium-ion batteries have issues such as such as leakage and swelling associated with liquid electrolytes. Despite the promise of solid-state electrolytes(SSEs) in enhancing battery safety and performance, challenges including low ionic conductivity and poor mechanical properties hinder their widespread adoption.. This research focuses on overcoming these obstacles by closely examining the mechanical properties and ionic conductivity of LiPON.

Process

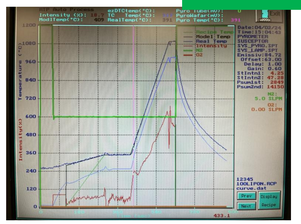


fig2

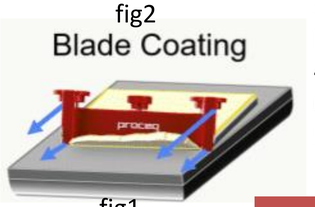
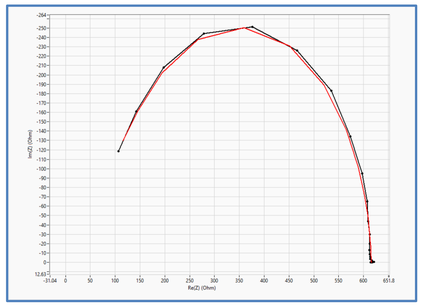


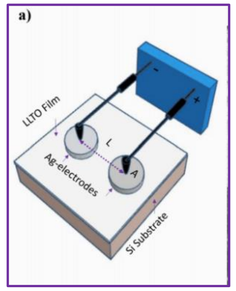
fig1

1. Dissolve 2.0g Li3PO4 and 0.1g Polyethylene Glycol(PEG) in 3ml Ethanol
2. Blade coating(fig1) at 900um at speed of 15, heat it on the 140 ℃ of hot plate for 10mintues.
3. Sinter it for 30s at 1100℃ using the RTA machine(fig2)
4. Measure ionic conductivity, uniformity and profilometry
5. Data collecting

Results/Analysis



Impedance

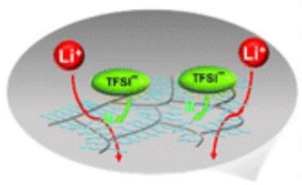


EIS measurement of 2 electrode in plane

- Resistance shows the battery's current carrying capacity.
- The graph showing a semicircle represents how much charge transfer resistance it made.
- The more resistance it has, the more ions cannot circulate to the cathode.
- EIS works by sending small amounts of alternating current to study its ionic conductivity and impedance of the battery cell sample.

Challenges/solution

PVP(Polyvinylpyrrolidone) was used as a binder to hold other materials together to form a cohesive. But the thin film kept coming off from the substrate and it made it hard to measure the ionic conductivity. Using PEG instead of PVP, it brushes acts as "Li+ bridges" to allow Li+ to migrate through various interconnected interfaces in the whole battery which led to more stable and high-energy-density solid-state batteries.



Migrating Li+

Future work

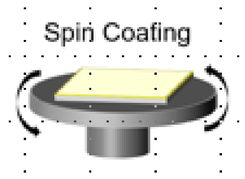


fig3

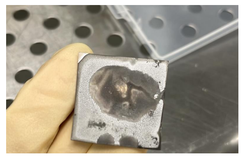


fig4

To achieve the enhanced SSE performance and lithium battery manufacturability, higher ionic conductivity per thickness values and shorter processing durations are required. Since blade coating could not make a film(fig4) as thin as it was desired, Spin coating(fig3) can be used. Spin coating is the process that could uniformly deposit thin coatings over the substrates by applying high speed spin to the

substrate to disperse the active materials using centrifugal force.

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Ira A. Fulton Schools of Engineering
Arizona State University