NDnano
Notre Dame Nanoscience and Technology

NDnano Undergraduate Research
2020-21 Winter Session Project Summary

1. Student name:

Josiah Viitala

2. ND faculty name & department:

Dr. Schaefer, Department of Chemical and Biomolecular Engineering

3. Winter Session project title:

Self-Charging Battery, Printable Battery, and Polysiloxane-based Single-ion Conducting Gel electrolyte

4. Briefly describe new skills you acquired during your Winter Session research:

Through my winter session research, I was able to learn about the inner workings of a lithium-ion battery, produce crosslinked polymer electrolytes using a UV multi-linker, an argon filled glove box, and a dielectric spectrometer in efforts to test the conductivity of various samples. I also learned how to use a potentiostat to measure the current passing through the sample electrolyte as a function of voltage.

5. Briefly share a practical application/end use of your research:

The desired practical application would be to use a piezoelectric material within a lithium-ion battery as to convert mechanical stress into electric energy to recharge the battery. Batteries could then be placed on U.S army troops in areas that undergo bending or impact such as a joint or pressure point that could apply mechanical stress on the battery resulting in recharging after use.

6. 50- to 75-word abstract of your project:

I worked on three different projects with the same overall goal as stated above. All focused on producing a working electrolyte for advanced lithium-ion rechargeable batteries while trying to incorporate a piezoelectric material into the process. Experiments done were in effort to produce an electrolyte with high conductivity and ion flow with crosslinked polymers.

Project summary:

The purpose of this research project was to test the conductivity of different crosslinked polymers using different ratios of solvents and solutes to make a working and reproducible electrolyte for lithium-ion batteries.

Project goal:

The first project, self-charging battery, focused on researching piezoelectric materials, collecting current resources on similar projects to learn more about the potential to create a rechargeable battery, and producing a working electrolyte with acceptable conductivity and ion flow. The second project, printable battery, focused on using polymers to make an electrolyte with the goal of mass producing the electrolyte through 3D printers. The last project, polysiloxane-based single-ion conducting gel electrolyte, had the goal to experiment with siloxane and siloxane hydroxide polymers to see if the electrolyte had a higher conductivity than the polytetrahydrofuran diacrylate-based polymer (PTHFDA).

Activities / results:

For the first project, a free standing PTHFDA polymer electrolyte with acceptable conductivity was produced and further testing using a glass fiber for structural support is in progress. In addition, further literature research into the use of piezoelectric materials in batteries is being conducted. For the second project, new polymers are being researched after several attempts fell short of the conductivity requirements using poly(ethylene glycol) diacrylate and PTHFDA as the cross linking polymers. For the third project, glass fibers were used to increase the structural stability of the polymer and made it possible to obtain a conductivity result. It was found that an acceptable conductivity level depended on the amount of time the sample spent swelling in dimethyl ether (DME). The longer time spent swelling, the higher the conductivity.