1) Student name: Dean Schaetzl
2) Faculty mentor name: Susan Fullerton
3) Project title: Aligning Conductive Pathways in Solid Polymer Electrolytes for Lithium-Ion Batteries
4) Briefly describe any new skills you acquired during your summer research:
I implemented a slow solvent evaporation method to prepare uniform thin films of solid polymer electrolytes to enable fundamental research. I used impedance spectroscopy to measure the conductivity of the polymer samples.
5) Please briefly share a practical application/end use of your research:
This project is the first step in creating batteries that are non-flammable, non-toxic, mechanically flexible and economical.

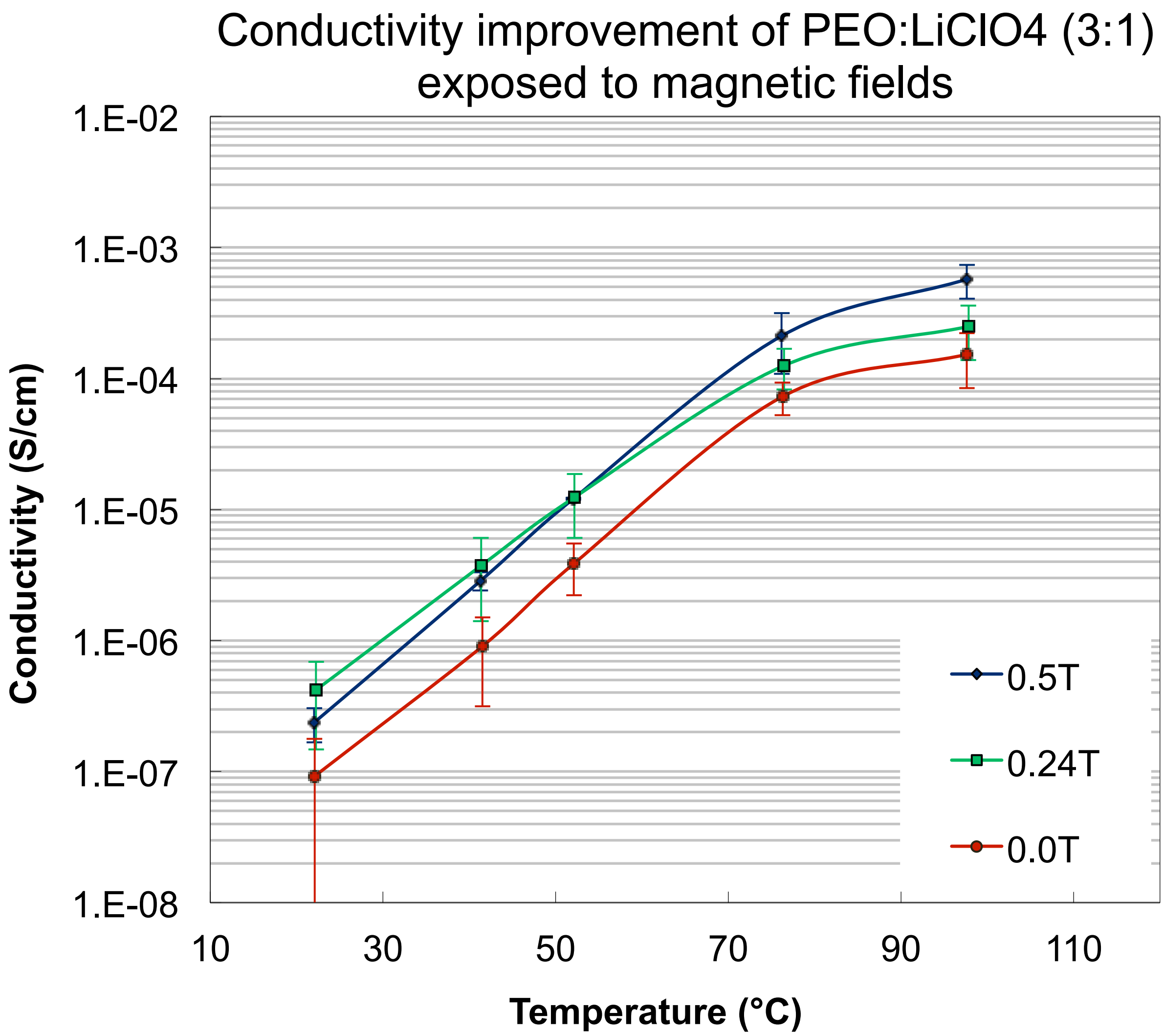
Begin two-paragraph project summary here:

Liquid or gel electrolytes currently used in rechargeable lithium-ion batteries can be toxic, explosive, and require a heavy, rigid casing. A solid polymer electrolyte (SPE) would be nontoxic, lighter and flexible without a rigid case, but SPEs do not have high enough conductivity (i.e., Li-mobility) at room temperature. Exposure to a magnetic field and the addition of nanoparticles improve conductivity but further improvement is needed for practical applications. Our previous work suggests that Fe_2O_3 nanorods induces the formation of a conductive crystal structure within the polymer electrolyte, and our goal is to align this structure normal to the electrodes to create conductive pathways that will further increase the conductivity of the SPE.

Before studying the effect of nanorods we characterized the unfilled SPE consisting of poly(ethylene oxide) [PEO] and ($LiClO_4$) at 4 ether oxygen to lithium concentrations of 3:1, 6:1, 8:1and 10:1 and under 2 magnetic field strengths of 0.24 and 0.5T. Exposure of the 3:1 sample in a 0.5T field improved the conductivity 3 times over the control when heated from 23 to 100˚C. This corresponds with differential scanning calorimetry (DSC) data showing that the magnetic treatment decreased the fraction of the non-conductive PEO_3:$LiClO_4$ crystalline phase in favor of the highly conductive PEO_6:$LiClO_4$ phase. With a PEO:$LiClO_4$ concentration of 6:1, a magnetic field strength of 0.5 and 0.24T increased conductivity 1.6 and 1.4 times respectively. At a concentration of 8:1 and 10:1 the magnetic field has no effect on conductivity.
After characterizing how the SPE responds to various magnetic fields as a function of $LiClO_4$ concentration, the next step is to add iron oxide (Fe_2O_3) nanorods.

Publications (papers/posters/presentations):
Poster: Undergrad Research Symposium. Notre Dame University, August 3rd 2012.
Poster: Midwest Institute for Nanoelectronics Discovery (MIND). Notre Dame University, August 8th 2012.

Paper submitted for publication
"Influence of Fe_2O_3 Nanofiller Shape on the Conductivity and Thermal Properties of Solid Polymer Electrolytes: Nanorods Versus Nanospheres".
Nhu Suong Do, Dean M. Schaetzl, Barnali Dey, Alan C. Seabaugh, Susan K. Fullerton-Shirey
(As a result of work done from spring 2011 thru spring 2012)


Conductivity improvement of PEO:LiClO4 (3:1)
exposed to magnetic fields
Conductivity (S/cm)
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
10
30
50
70
90
110
Temperature (°C)
0.5T
0.24T
0.0T