PhD DEFENSE STUDENT: Taylor Kelly

DATE: Thursday, November 10, 2016

TIME: 9:00 AM

PLACE: Mechanical Engineering Large Conference Room

DISSERTATION CHAIR: Dr. Haleh Ardebili

TITLE:

INVESTIGATION OF THE MECHANO-ELECTROCHEMICAL COUPLING OF SOLID POLYETHYLENE OXIDE AND STRETCHABLE LITHIUM ION BATTERIES

It is necessary to develop deformable energy storage devices that are compatible with the next generation flexible and stretchable electronics such as medical implants and wearable devices. Lithium ion batteries are a popular energy storage method for modern technology that provides high energy density and efficiency. However, the electrochemical instability of the organic liquid electrolytes poses a real hazard to using conventional lithium ion batteries in deformable electronics. Replacing the liquid electrolyte with a solid polymer reduces the risk of the battery setting aflame among many other benefits. Solid polymer electrolytes are of particular interest to battery scientists because they allow for the development of safe and deformable batteries. On the other hand, solid polymer electrolytes are also disadvantaged because of their poor ion transport properties. There has been extensive research in improving the ion conductivity of solid polymer electrolytes, but the best achievable conductivities are still two orders of magnitude less than that of liquid electrolytes.

The present study investigates the feasibility of using solid polymer electrolytes (i.e. polyethylene oxide) in stretchable lithium ion batteries. The ion conductivity of a solid polymer electrolyte film is demonstrated to increase with tensile strain and this research delves into the mechanisms behind this conductivity improvement. The coefficients of ion conductivity enhancement are found to be similar in both in-plane and out-of-plane directions. Furthermore, molecular weight blending (i.e. 100k and 600k Mw) is used to enhance the electrochemical properties of the solid polymer electrolyte while minimally affecting the polymer's mechanical stability. The relatively optimized stretchable polymer electrolyte is tested inside a sliding electrode battery and the effect of tensile strain on overall battery performance is investigated.