Project Title: Processing of single-material solid-state lithium batteries

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Project Description: Owing to their inherently safer nature, solid-state batteries have attracted tremendous attention as a substitute for conventional liquid-electrolyte lithium-ion batteries. There are, however, several drawbacks associated with the application of solid-state batteries. One of the more significant drawbacks is the high inherent interface resistance between electrodes and solid electrolyte due to poor contact between these components. In this research project we will fabricate solid-state batteries from superionic conductive LGPS (see Figure 1) solid electrolyte and study the effect of compositional gradients with the purpose of minimizing abrupt material variations across the electrode/electrolyte interface. These compositional gradients are expected to lower the interfacial resistance and improve the efficiency of novel solid Li batteries.
As an undergraduate research assistant, your duties will include fabrication of bulk solid-state batteries based on the concepts described above. Battery fabrication will be carried out through powder compaction and possibly high temperature sintering. Material and microstructural characterizations will be conducted to assess the quality of the processed samples. Electrochemical response of the fabricated battery samples will be evaluated through cyclic voltammetry. The final goal will be to optimize the material gradient such that the battery will sustain electrochemical and mechanical stability over long periods of time and cycles.

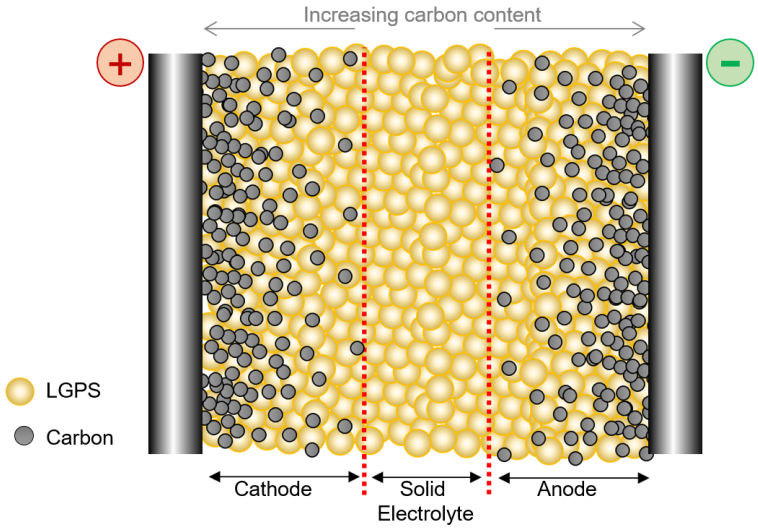

Figure 1. Schematic representation of a solid-state battery fabricated from high conductivity $Li_{10}GeP_2S_{12}$ (LGPS) as the base material. Carbon powder is used as electronically-conductive material in cathode and anode. Continuous (or piecewise) gradation of carbon content in electrodes is expected to minimize the mechanical damage due to abrupt property changes.

Student Background and Expected Research Activities:
We are seeking a self-motivated and enthusiastic student who is interested in *material processing, energy storage,* and *electrochemistry*. Prior experience in these areas is desired, but not required. Experience with handling air-sensitive materials and/or the use of *glove-box* is desirable. The student should be capable of operating simple material processing equipment, follow strict safety protocols, follow procedures in a precise manner, and possess strong communication skills.

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