Director/PI: Prof. Gregory Guzik

The objective of this collaborative proposal is to develop safe and high capacity batteries for NASAs future missions. To achieve this objective, we will develop a new solid-state electrolyte (SSE) capable of promoting uniform lithium plating that suppresses the formation of dendrite and prevents thermal runway. The proposed SSE possesses high conductivity and exhibits low reactivity against lithium-metal anode, a central component for high capacity battery. An experimentally-verified, physics-informed, theoretical framework will be developed for predicting the thermal and mechanical stability and long-term performance of the proposed batteries.

Future solar system exploration priorities identified by NASA seek to reach targets of broad scientific interest across the solar system. All of these missions must carry some form of energy storage. The extreme environments of planetary missions require considerable evaluation, adaptation and testing of the energy storage components and their subsystems, for planetary missions are far more demanding than the applications on Earth. Thus, the 2020 NASA Technology Taxonomy from the NASA Office of Chief Technologist has identified development of advanced energy storage as a transformational technology (TX03.2). The proposed research is also closely aligned with the Louisianas research priorities in materials science and advanced manufacturing.

In this project we will address the overarching challenges in developing high-performance and safe solid-state batteries, including: (1) what are the necessary chemistry and architecture for high-performance SSEs to enable a desirable electrochemical and mechanical property that can properly function in severe space environment in the presence of radiation and low temperatures; (2) how an interface can be created at the SSE, which can facilitate the Li ion-migration across this solid-solid junction while remaining stable against Li-metal anode and high-performance cathode; and (3) what is the thermodynamic origin for the formation of uniform Li-plating and Li-dendrites, and how this can be translated into developing cell materials and architecture to suppress dendrite formation. In this research, we expect to develop novel materials, electrolyte architecture, and theory for the safe and ultra-high capacity batteries.

The scientific effort of this project will be undertaken by an interdisciplinary team of researchers from University of Louisiana at Lafayette, Louisiana State University in Baton Rouge, and Louisiana Tech University. This team will collaborate with NASA partners at Glenn Research Center and Jet Propulsion Laboratory as well as industrial partners at General Motors and IBM on high-capacity anode development and testing, performance evaluation in a simulated space environment, and independent validations of the materials and batteries developed by the team.

This project, if funded, can place our team in a leading position in the area of energy storage, which is now a research priority in many federal agencies. The complementary expertise among Co-Investigators will lead to long-term collaboration at three Louisiana universities, multiple NASA centers as well as industrial partners to ensure a broad impacts for years to come.