ABSTRACT – Development of anode-less technology for high-energy density batteries

The project aims to develop an anode-less battery technology that enhances energy density and ensures efficient lithium plating/stripping cycles without requiring excess lithium compensation. To achieve this, the research will explore multiple strategies using coin and small pouch cells (0.1 Ah) with bare copper foil as the baseline. These strategies include the development of laser-textured 3D copper foils with increased surface area to reduce local current density and minimize dendritic lithium formation, as well as the use of lightweight metallized polymer films to replace conventional copper foils.

Surface modifications will also be implemented to optimize lithium deposition, including the application of lithiophilic metallic coatings such as silver, tin, and magnesium through electrodeposition and magnetron sputtering. Thin polymer-carbon composite layers will be developed via doctor blade techniques to enhance conductivity, thickness, and porosity, while various additives—such as metal triflates, cyanates, silanes, and boronoxalates—will be tested to further improve lithium plating.

The most promising candidates from these efforts will be scaled up and tested as anode materials in 0.1 Ah cells paired with NMC cathodes. Comprehensive structural and electrochemical characterizations will be conducted using advanced techniques like SEM, EDX, TEM, and EELS to examine material cross-sections, identify side products, and evaluate electrolyte interactions with the current collectors. Electrochemical testing will assess the materials' performance in both asymmetric (vs. lithium metal) and full-cell (vs. NMC811) configurations. The ultimate objective is to achieve a quasi-solid-state battery with 80% capacity retention after 500 cycles at a 2C charge rate, delivering scalable, efficient, and sustainable high-performance battery technology.