Opportunities and Challenges for In Situ Synchrotron Characterization of All Solid State Batteries

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Electrification of the transportation sector relies on radical re-imagining of energy storage technologies to provide affordable, high energy density, durable and safe systems. Next generation energy storage systems will need to leverage high energy density anodes, like Li to achieve the required performance metrics (longer vehicle range, long life, production costs, safety). Solid electrolytes (SEs) are promising materials for achieving these metrics by enabling Li metal anodes and high voltage cathodes, but SE cells suffer from poor coulombic efficiencies as well as lifetimes which impede their integration into EVs. In this talk, I will discuss two promising material candidates (garnets and thiophosphates) and their underlying processing-structure-function relationships. I leverage in situ synchrotron techniques to elicit the mechanisms of failure within these systems. Electrolyte structure anisotropy is identified to be a key factor that initiates failures in solid electrolytes. Subsequently, I will discuss some ongoing work pertaining to development of operando cells for SSB testing. Finally, I will discuss potential research questions of fundamental interest with regards to solid|solid interfaces that can benefit tremendously from directed efforts of leveraging advanced diffraction techniques.