GRadient- and multi-mat**E**rial proc**E**ssing of **N**ext-generation solid-state-lithium **BA**tteries using direct ma**T**erial processing (GREEN-BAT)

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Solid state batteries (SSB) promise significant improvements over conventional lithium-ion systems in terms of energy density, safety, and thermal stability. However, their manufacturing is challenged by issues related to compatibility between the solid electrolyte and electrodes, material densification, and the scaling of production methods originally designed for liquid-based systems. In this work, we have processed state-of-the-art SSB materials using advanced thermal spray techniques to fabricate all-solid-state lithium batteries (ASSLB) in a single-step process. This integrated approach dramatically increases production rates while overcoming limitations in size, shape, and multi-step fabrication processes typically associated with traditional methods. Furthermore, the use of thermal spray techniques enables the production of SSBs with complex geometries via robotic deposition. We developed single-layer independent ASSLB constituents for the three key electrodes (anode, cathode, and electrolyte), as well as half-cell and full cell configurations, utilizing several thermal spray techniques such as Atmospheric Plasma Spray (APS), Suspension Plasma Spray (SPS), High Velocity Oxy-Fuel (HVOF) spray and Flame Spray (FS). Additionally, phase evolution at the electrodes and their interfaces was studied using advanced synchrotron techniques. μXRD analyses revealed that phase changes during deposition are highly influenced by the heat input, and optimizing these parameters significantly minimizes undesired phase transformations. Battery performance studies of the fabricated cells further confirm that, with the proper optimization of processing parameters, thermal spray can serve as a viable manufacturing process for both full cell ASSLBs and individual electrode components.

The talk and poster will cover the introduction and challenges of manufacturing ASSLBs, along with the proposed methods to overcome these limitations. It will present the final product results, along with characterization and performance testing. Future directions and scope will also be discussed.