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ELECTROCHEMICAL-MECHANICAL INTERACTION IN SOLID POLYMER ELECTROLYTE BATTERIES

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Solid polymer electrolytes (SPEs) have enormous potential for the next generation of batteries thanks to their advantages ranging from low flammability and good mechanical strength to excellent processability and flexibility. These characteristics make SPE-based batteries appealing when a structural response is also needed as in medical applications, wearable electronics, and structural batteries [1].

When a battery doubles as a structural component, it is subjected to external loading (or deformation). Under these circumstances, mechanical loads can affect transport of ionic species in the SPE and lithium transport in the active material (e.g., $LiCoO_2$ and graphite), and the electrochemical processes—lithium ions' insertion into and extraction from the active material and their transport in the SPE—can change the stress and strain state of the battery. Since the electrochemical-mechanical coupling may affect the normal functioning of the battery and decrease its mechanical strength, we need to carefully study the electrochemical-mechanical interaction to strike a balance between energy storage and structural functioning.

In this contribution, we consider a battery cell, consisting of three layers of anode, separator, and cathode, under external loading at the microscale level. A coupled electrochemical-mechanical model for the SPE and the active material [2] will be established to evaluate the battery electrochemical response under mechanical loading and, conversely, the effect of the battery normal operating conditions on its mechanical response.

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