Avviso Seminario

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Modeling dendrite growth into solid-state lithium battery electrolytes

Abstract

All-solid-state lithium (Li) batteries provide a promising pathway toward high energy and power density. Dendrite penetration through the solid electrolyte causing battery to short-circuit, however, has been one of the challenges impeding their widespread application. Here, considering a pre-existing surface crack in the electrolyte and assuming Li deposit to behave in accordance with rigid-viscoplasticity, we seek for the steady state Li-filled crack opening profile that would form at a given constant current density. Taking the ion-conductivity of the electrolyte to be large, the coupling between stress buildup in the dendrite, deposition rate, visco-plastic flow of Li deposit, and crack opening induced by electrolyte deformation are incorporated in the model using singular integral equations of fracture mechanics. The model establishes limiting conditions for crack growth before a steady state dendrite is reached, triggering a cycle of crack growth and dendrite elongation. Using material properties adopted from literature, the model predicts that the critical condition can be met for a microcrack at typical current densities. The effect of pressure applied to the cell is further discussed

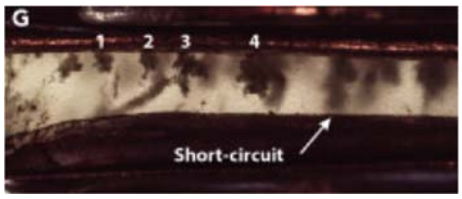

Image from Eric Kazyak, Regina Garcia-Mendez, William S. LePage, Asma Sharafi, Andrew L. Davis, Adrian J. Sanchez, Kuan-Hung Chen, Catherine Haslam, Jeff Sakamoto, Neil P. Dasgupta, Li Penetration in Ceramic Solid Electrolytes: Operando Microscopy Analysis of Morphology, Propagation, and Reversibility, Matter, Volume 2, Issue 4, 2020, 1025-1048.

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