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Contact loss in all solid-state Li-ion batteries via deposition of impurities

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Abstract

Solid-state batteries promise high energy storage with enhanced safety but suffer from contact loss at the lithium (Li) metal anode-solid electrolyte interface as Li is stripped into the ionically conducting solid electrolyte. Our measurements demonstrate that, in cells with garnet electrolytes, contact loss arises from the deposition of insulating impurities from within the Li electrode onto the interface. These impurities form a porous layer, and an imposed stack pressure is required for Li to creep through this layer. Insufficient stack pressure results in empty pores between the impurity particles and these pores resemble nano to micro-scale voids. This proposed mechanism is supported by our direct observations of the interface and by our finding that contact loss persists at stack pressures that are sufficiently high to collapse any voids in the Li that are not mechanically supported by the skeleton of impurity particles. Theoretical models developed using the impurity deposition mechanism are in excellent agreement with measurements. This finding has significant implications for improving the design of all solid-state batteries including the development of anode-free cells for which impurities within the electrode are expected to be substantially reduced.

Keywords:

Void formation Anode free Stack pressure