Abstract #251, 224th ECS Meeting, © 2013 The Electrochemical Society

Three Dimensional Simulation and Optimization of Microbatteries

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The advent of new additive manufacturing technologies has opened up the design space for microbattery fabrication. High surface area electrode designs that were once limited to theoretical papers can now be built at the micron length scale, allowing batteries to achieve both high energy density and high power density. However, there are a large number of design parameters to consider (e.g. electrode length, width, porosity, shape) as well as constraints given by the microfabrication technology (e.g. minimum spacing and width).

The focus of this work is the optimization of lithium cobalt microbattery architecture using three-dimensional finite volume simulation and modeling of heat, charge and mass transfer in microbatteries. A gradient-based optimization method is used in conjunction with the simulation tool to obtain optimized microbattery designs. Simulation and optimization results are presented along with experimental validation.