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Optimization under Uncertainty Tool for Modeling Porous Lithium-Ion Batteries

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ABSTRACT

The motivation of this tool is to optimize the performance of battery based on energy output. During the manufacturing process, several parameters such as cathode thickness, the volume concentration of cathode and radius of negative active materials are subject to uncertainty. To optimize battery performance, it is significant to quantify those uncertainties through electrochemical multiscale computer simulation. Hence, this tool will focus on the optimization of the performance of lithium-ion battery under different currents. This tool will consist of a module on visualized generator of uncertainty input, an electrochemical system simulator, a visualization of output optimization module. First, the uncertainty input generator provides the option for selecting one of several statistical models for the input parameter distributions. The method of moment matching and Gauss-Hermite quadrature formula are used to simulate distribution. Simulations are performed using an existing electrochemical system simulator that in turn uses the data obtained from the uncertainty input generator to simulate energy and power, which can be considered as a black-box function. The simulation results are quantified graphically through error bar plots that visualize the impact of the uncertainties. For the optimization part, the variation and optimization of power and energy densities as a function of current density of the battery electrode are presented using GPy package and the result are obtained and plotted under uncertain input parameters. Bayesian optimization will be utilized to determine the global optimization through the black-box function. Additional work may be needed to include more of the uncertain variables in this framework.

KEYWORDS

Uncertainty Quantification, Battery Simulation, Optimization