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An Experimentally Validated Transient Thermal Model for Cylindrical Li-ion Cells

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Abstract

Measurement and modeling of thermal phenomena in Li-ion cells is a critical research challenge that directly affects performance and safety. Even though the operation of a Li-ion cell is in most cases a transient phenomenon, most available thermal models for Li-ion cells predict only steady-state temperature fields. This paper presents the derivation, experimental validation and application of an analytical model to predict the transient temperature field in a cylindrical Li-ion cell in response to time-varying heat generation within the cell. The derivation is based on Laplace transformation of governing energy equations, and accounts for anisotropic thermal conduction within the cell. Model predictions are in excellent agreement with experimental measurements on a thermal test cell. The effects of various thermophysical properties and parameters on transient thermal characteristics of the cell are analyzed. The effect of pulse width and cooling time for pulsed operation is quantified. The thermal response to multiple cycles of discharge and charge is computed, and cell-level trade-offs for this process are identified. The results presented in this paper may help understand thermal phenomena in Li-ion cells, and may