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Detecting and modeling the onset of short circuit in a Li-ion cell under mechanical loading

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Abstract

Computational models for evaluating performance of Li-Ion cells are necessary to reduce costs of testing and to accurately predict failure under abuse conditions. Detailed constitutive and computational models capable of predicting failure, to date, have not been published in the open literature for Li-Ion cells, modules, and battery packs. The present work is concerned with studying behavior of Li-Ion pouch cells. Such cells have a very complex internal structure with multiple layers of various materials, similar to a composite laminate. The objective of this work is to detect and model the onset of short-circuit under conditions of mechanical abuse. In this study, a homogenized model of the interior structure was developed and calibrated through a set of carefully planned experiments. A set of punch indentation tests was conducted using rigid hemispherical punches while monitoring load, displacement, temperature and voltage output of the individual cells. The previously developed model was calibrated against physical test results by choosing the proper tensile cutoff value for the average tensile strength of the electrode/separator assembly. The FE simulation perfectly represents the overall results seen in physical testing. The model of a single cell is a starting point in the development of more complex systems such as modules and battery packs. Ultimately the battery pack can be coupled with FE models of whole vehicles and would be useful in evaluating damage to the packs in the event of a vehicular crash. Such a model can be used to ensure properly engineered battery packs for hybrid and electric vehicles, potentially minimizing weight and production cost while maximizing safety.

***Keywords**:* Lithium-Ion Batteries, Mechanical Integrity, Cylindrical Cell.