Impact Response of Lithium Ion Batteries

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Safety of large format lithium ion batteries has been an active area of research for several decades. Mathematical models have been developed to simulate several failure modes including, but not limited to short-circuit, overcharge, over-discharge, thermal ramp, mechanical compromise, and internal defects. A variety of experimental techniques such as the nail penetration, ball (or bar) crush test, pinch test, overcharge and the hotbox test have been developed to relate the response of the battery under controlled abuse conditions to field events. The conclusions from previous studies range from classification of the operating range of the battery into “safe” and “unsafe” zones, to suggestions that controlled abuse tests are not representative of field incidents.

In this work, we present simulation results quantifying the mechanical response and the ensuing thermal/electrochemical behavior of large format lithium ion cells under realistic impact scenario. These results are in turn compared to previous simulations of controlled abuse tests and some experimental results. The conclusions will identify the similarities between the two sets of results and the gaps that exist in the experimental evaluation of battery safety.