Abstract for oral presentation

Modelling and measurement of uneven heat generation in lithium-ion battery packs

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Lithium-ion battery packs for automotive applications typically consist of hundreds of cells connected in series and parallel to achieve practical voltages and capacities. Depending on the pack architecture, interconnect resistances can cause uneven current loadings in cells of the same parallel cell strip due to different resistance pathways, with cells nearer the pack current collector experiencing higher currents than those further away. This leads to localised heating of cells and a change in the pack performance due to the temperature dependency. Pack assembly faults can result in still higher interconnect resistances which, depending on the magnitude of the resistance, can effectively isolate certain cells in a pack [1].

It has been shown experimentally and via simulations that a current interrupt technique can be used as a low cost and fast method of detecting the location of faults in a large battery pack [1]. Combined with simulation results using a Newman based coupled 1D thermal-electrochemical battery model integrated into a pack model, we show that the rebalancing of currents can take on the order of 100s of seconds with constant current loads, and may never reach steady state under the dynamic loads typically seen in automotive applications. Results show localised heating in the cells nearest the current collectors of a large pack and a continued heat generation after load removal due to rebalancing caused by differences in the open circuit potentials of parallel cells. If not accounted for, this could lead to operation outside of the manufacturers prescribed limits and possible thermal runaway (ref Fig. 1).

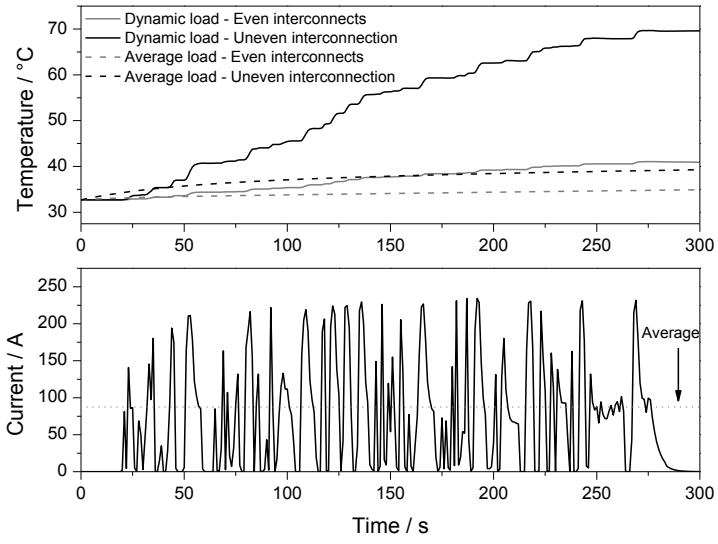

Fig. 1: Simulated temperature of the hottest cell in a 12P7S battery pack under static and dynamic loads with equal and unequal interconnect resistances

This uneven heat generation and current redistribution is well documented on the cell level but has not been well explored on the pack level. This effect therefore becomes an important consideration to pack designers and battery management system developers.

[1] G.J. Offer, V. Yufit, D.A. Howey, B. Wu, N.P. Brandon, Journal of Power Sources 206 (2012) 383.