Understanding the effect of temperature gradients in modules on cell balance using coupled multi-physics modeling approach

S. Pannala, S. Allu, W.R. Elwasif, S. Kalnaus,
S. Simunovic, and J. A. Turner
Oak Ridge National Laboratory
One Bethel Valley Road, Oak Ridge, TN-37831

Reliable and safe operation of a Li-Ion Battery pack depends greatly on extracting the full capacity with minimal degradation over the life time. Balancing the cells in a Li-Ion battery pack is a critical aspect to achieve this goal as any cell imbalance leads to suboptimal utilization of the battery pack. Cell balancing is affected by various factors such as differential degradation of the cells due to manufacturing variability, improper voltage control, and non-uniform temperature in the pack. In this paper, we will present a systematic study of the role of temperature gradients in a module on discharge of individual cells that lead to cell imbalance.

We will conduct these studies on two different module configurations subjected to various temperature gradients that mimic the overall cooling heterogeneities in a pack. Both of these configurations will include four pouch cells connected in series and parallel. The Finite Element discretization of the battery modules is shown in Figure 1. Convective cooling is imposed on the front and back of the module. The 3D multi-physics model of Li-Ion pouch cell employed in this study is validated earlier with the experimental data at various discharge rates [1].

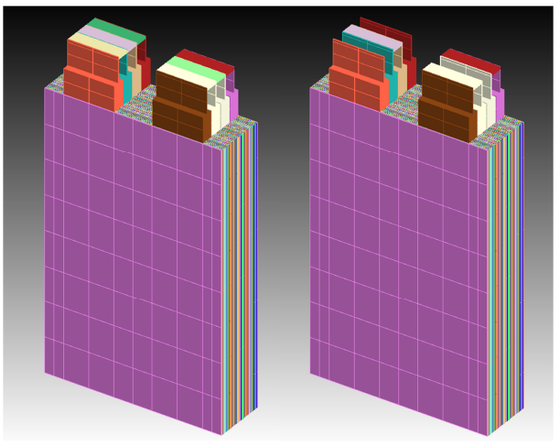

Figure 1: Discretization of Battery Module in series and parallel.

References:

[1] Allu S., Kalnaus S., Elwasif W.R., Simunovic S., Pannala S., Turner J.A., "Highly-resolved coupled 3D multiphysics simulations of Li-Ion Cells ", *Journal of Power Sources*, 2013 (To be submitted).