Optimization of Tab Placement in Li-ion Battery using Multi-Physics Simulations

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Thermal management of the Lithium-ion battery systems can greatly influence their performance and life. Effective cooling mechanisms and appropriate positioning of the current collector tabs are important design choices for the battery. In this paper we will demonstrate the capability of the Open Architecture Software (OAS) framework to optimize the tab placement using computational simulations and the optimization toolkit Dakota [1].

The optimization is driven by the objective to minimize the temperature gradients in the battery. The temperature gradients are computed using the three-dimensional coupled multi-physics model of Lithium Ion pouch cell as discussed in paper [2]. The battery model used in this study has been validated by the experiments conducted at various discharge rates [2].

The schematic of the standard pouch cell is shown in Figure 1. Convective cooling is imposed on the front and back of the cell. This results in significant temperature variation though the cell thickness as shown in Figure 2 during 5C discharge. To obtain the optimal location of tabs all the geometric descriptions to construct the discretization have been parameterized. This allows for

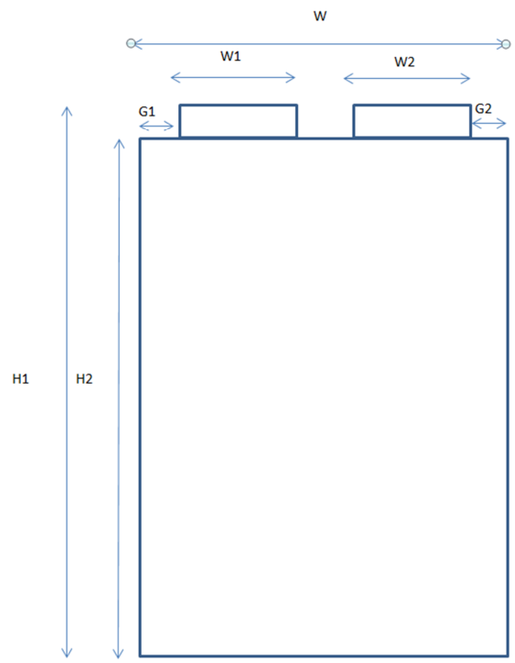

Figure 1. Schematic of Pouch Cell

the program to be able to place the tab anywhere on the perimeter of the pouch cell.

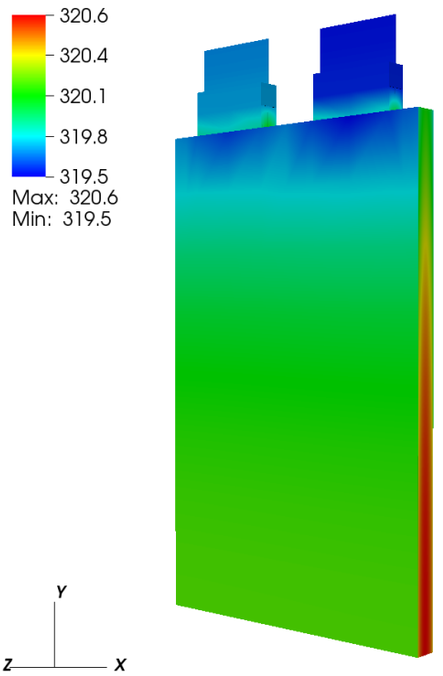

Figure 2. Temperature distribution at 5C discharge

Initial parameter sweep study will be conducted in order to understand the sensitivity of the response to the design variables. Computational performance and robustness of various gradient based optimization algorithms will be presented.

References:

[1] Elwasif, Wael R., David E. Bernholdt, Sreekanth Pannala, Srikanth Allu, and Samantha S. Foley. "Parameter Sweep and Optimization of Loosely Coupled Simulations Using the DAKOTA Toolkit." *IEEE 15th International Conference on Computational Science and Engineering (CSE)*, pp. 102-110. IEEE, 2012.

[2] 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).