Thermal Analysis of a Latent Heat Storage based Battery Thermal Cooling Wrap

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Introduction: The most common cause of lithium ion battery failure is high temperature. Improper and inadequate battery thermal management strategies contribute to such temperature related failures. Excessive built-up heat during operation significantly impacts the performance, safety and cycle life time of the battery [1]. Therefore, a proposed latent heat storage based battery cooling wrap, shown in Figure 1, is used to passively manage the heat dissipated from the cell [2,3], keeping it within the safe operating temperature range.

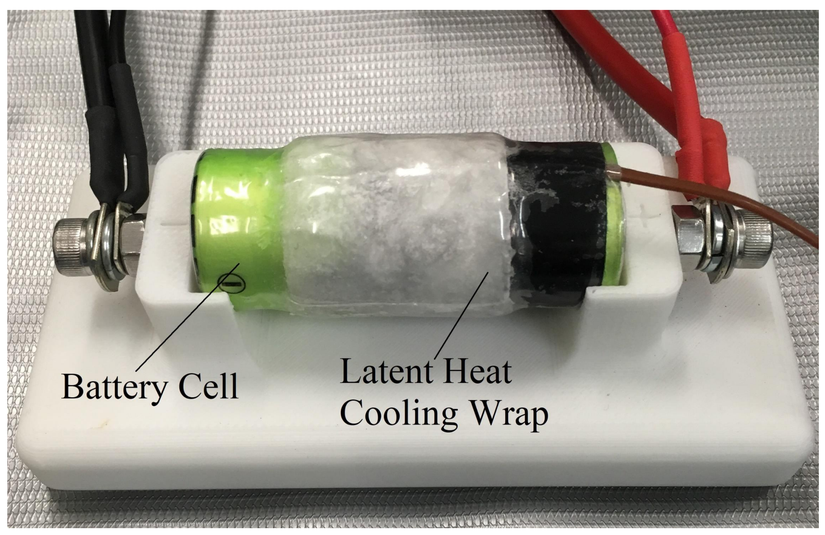

Figure 1. Proposed Latent Heat Storage Based Battery Cooling Wrap

Computational Methods: A 2D axisymmetric model of a 26650 $LiFePo_4$ battery cell wrapped with a phase change material (PCM) embedded in a absorbent material. A 1D lithium-ion battery module was used to simulate the electrochemical heat generation in the cell; and a 2D heat transfer module with phase change was used to simulate the heat transfer between the battery cell and the latent heat cooling wrap.

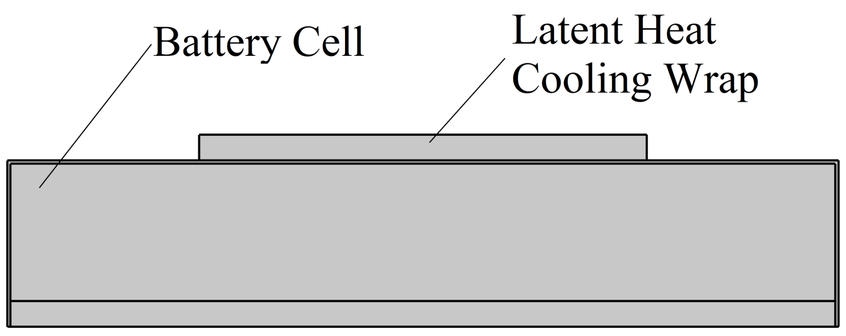

Figure 2. 2D Battery Model with Cooling Wrap

Results: Battery was discharged at 2C (5A) at lab temperature of 23 degC. The latent heat cooling wrap reduced the cell temperature from 35.9 degC to 30.9 degC. Comparison study carried out between simulation and experiment came to close agreements.

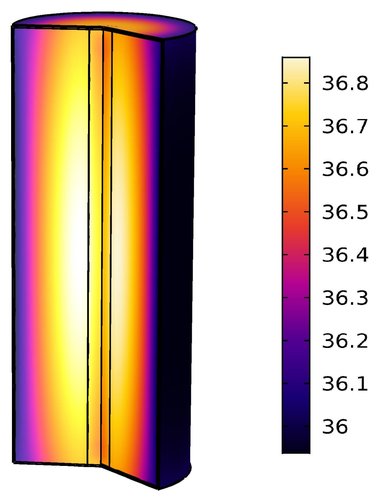

Figure 3. Bare Cell

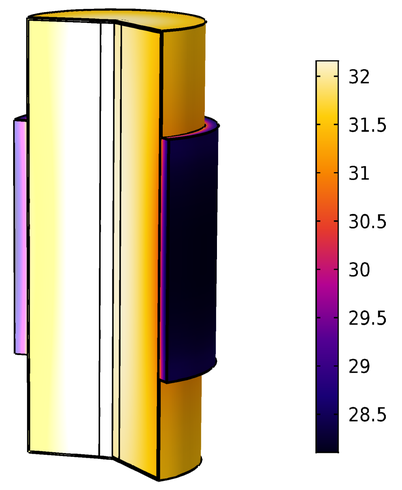

Figure 4. Cell with Cooling Wrap

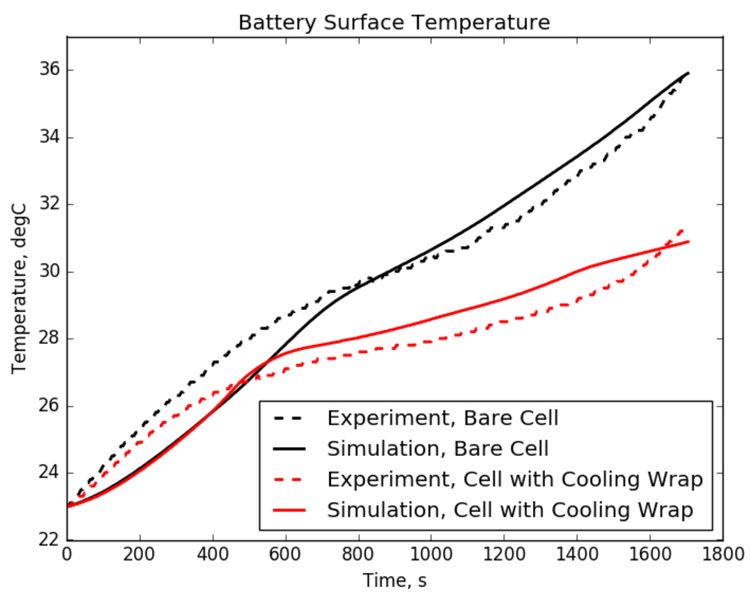

Figure 5. Simulation vs. Experimental Results

Conclusions: An accurate thermo-electrochemical lithium-ion battery model can be used to predict its thermal behaviors and validate the proposed battery thermal management strategy. The simulation proved the feasibility of the cooling wrap as a viable battery thermal management solution.

References:

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