# Thermal Design for Lithium Sulfur Batteries

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## Abstract

OXIS Energy Ltd is a pioneer in the research and development of Lithium Sulfur batteries. As we scale up our batteries from R&D level coin cells to pouch cells for automotive use, engineering design and thermal management start to become critical. For example, larger cells can trap heat within leading to accelerated degradation of the cell. The presence of metallic lithium foil as an anode material also brings up a set of challenges unlike those found in standard commercial lithium ion batteries, due to its lower melting point. In this study, we look at heat flow at various levels of the cell. We analyzed different heat flow scenarios of the cell, and found that standard pack arrangements might require for tab cooling to be used.

We first focus on the tab region, comparing and contrasting the effects of different tab morphologies. It was found that thicker and wider tabs can significantly impact the flow of heat through the cells. This is primarily because of the material properties of the cell, which bias flow in the tab direction rather than the surface. (Figure 1) For this study the Heat Transfer Module was used along with the LiveLink™ for MATLAB®, which enabled us to perform parametric studies on a wide range of parameters and also to analyze the data in order to determine the best configuration for the cell.

Finally, a close look is taken at the weld between the tabs and the electrodes, to see if the resistance at this point also plays a role. An innovative coupon design was used in order to obtain results which were then experimentally validated, as can be seen in Figure 2. The effect of heating due to current was modeled using the inbuilt Joule Heating interface of COMSOL Multiphysics®. This module couples the Electric Currents interface with the Heat Transfer in Solids interface in order to give the combined effect of heat flow and electric currents.

It was found that the values of these resistances are low in comparison to the actual tab resistance, but this will change when wider and/or thicker tabs are used, due to the Joule heating present in the tabs themselves. Different scenarios were also tested, in order to examine the effect of a poor weld with high resistance and a scenario with no weld resistance. It was found that the resistance would have to be increased by two orders of magnitude in order to have a noticeable impact, which potentially means this is a term which can be neglected in overall heat modelling of the cell.

# Figures used in the abstract

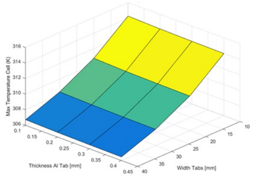


**Figure 1:** Plot of maximum temperature for an OXIS cell after a 1C discharge with Nickel/negative electrode tabs of 0.2 mm thickness and 20 mm width. The variation is plotted over the change in dimensions for the Aluminium/positive electrode tab.

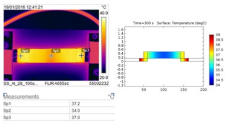

**Figure 2:** Experimental validation of model parameters for weld resistance . Figure (a) shows the experimental setup and figure (b) shows the results from the model. The weld was between aluminium tabs of 100 um thickness and 28 aluminium foils. The current passed is 50 A and the time of measurement for both is 5 minuts.