

Monitoring heat generation of batteries



Introduction

Thermal control of batteries is getting more and more important for:

- Increasing lifetime
- Fast charging
- Avoiding thermal runaway

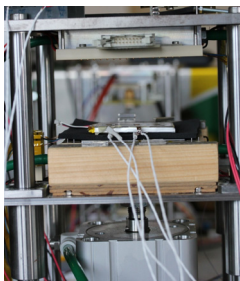


With active cooling or heating of batteries, thermal characterization with temperature sensors becomes less effective. With its OEM heat flux sensor, greenTEG provides an affordable solution to this problem.

Experimental Setup

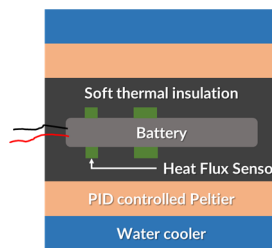
- Li-Polymer battery 62mm x 72mm
- Active temperature control with Peltier elements (temperature feedback loop)
- Heat flux sensing with g-SKIN® heat flux sensors

Overall Setup



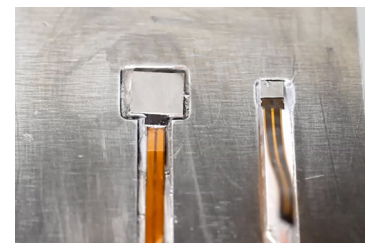
Arrangement 1:

Heat flux homogenization around battery by thermal insulation material (foam rubber)



Arrangement 2:

Fast heat transfer by recalibrated heat flux sensor plates



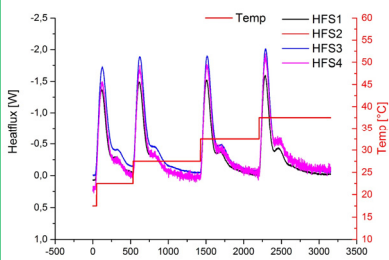
Step 1:

Heat capacity (Cp) determination

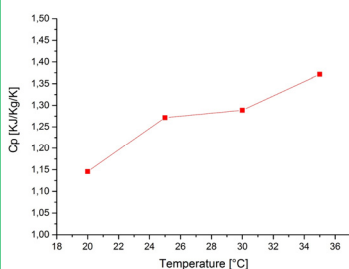
Procedure

1. Keep battery temperature constant
2. Apply a temperature step
3. Measure heat flux response
4. By integrating the heat flux, the specific Cp can be determined

Results



Heat flux response on a series of temperature step. Integration of the peaks yields the energy absorbed by the material.



Dividing the determined overall energy by the material mass results in the specific heat capacity

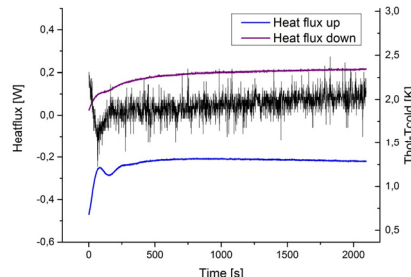
Step 2:

Thermal resistance determination

Procedure

1. Apply a temperature difference between upper and lower side
2. Measure heat flux response
3. $K = \Delta T / Q$

Results



Measured heat flux at the upper and lower side of the battery while applying a temperature difference between top and bottom side. The thermal resistance at steady state condition yielded: **9 W/m/K**

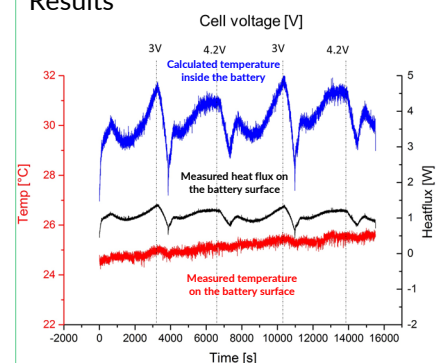
Step 3:

Inner temperature determination

Procedure

1. Keep battery at $\sim 25^\circ\text{C}$
2. Cycle battery between 3 V and 4.2 V
4. Measure heat flux response
5. $T_{\text{inside}} = T_{\text{outside}} + f(Q)_{\text{Cp, K}}$

Results



Heat flux (black) and temperature response (red) as measured at battery surface.

The temperature inside the battery is determined by knowing the heat capacity and thermal resistance of the battery.

Conclusion

- T-sensor signal does not show charging cycles
- Heat flux sensors show well resolved charging/decharging signal
- Determination of heat generation inside the battery using heat flux sensors is easy and reliable