Calorimetric measurements of batteries using gSKIN® Heat Flux Sensors

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Introduction

For understanding the thermal behavior of batteries heat flux sensors can be applied. Today, most thermal measurements of the batteries are conducted with use of temperature sensors and/or battery calorimeters. However, this approach es can either be unreliable, time consuming or very costly. With greenTEG’s heat flux sensors, calorimetric measurements become feasible and affordable.

Example: Integration of gSKIN heat flux sensors into a measurement setup
Advantages of gSKIN® heat flux sensors

- Small size heat flux sensor (e.g. 4.4 x 4.4 mm) with high sensitivity, easy to use on pouch and cylindrical cells
- OEM sensor (2mm x 2mm) for prize sensitive high volume products are available on request
- Measures heat (Q-value) into and from the battery directly
- Entropy profiling become feasible (footprint for SOH determination)
- Space resolved measurements
- Increased detection speed and reduced uncertainties in end of line testing
Application 1: Measuring entropy profile in batteries

Easy to use for entropy profiling at the battery surface

- SOH determination
- End of line testing
- Life time and aging investigations
- Detection of electrode disbalancing

These results show that highly resolved entropy profiles can be recorded.
Application 2: Measuring of the inner temperature

Dr. Lukas Durrer (greenTEG AG) evaluated the use of gSKIN®-XP heat flux sensor for determination of the thermal capacity of batteries and as well as the thermal conductivity and inner temperature of the battery in use.

Heat flux (black) and temperature response (red) measured at the battery surface. The temperature inside the battery (blue) is determined by knowing the heat capacity and thermal resistance of the battery.

Video showing complete setup and measurement results
https://www.youtube.com/watch?v=D2uP4vNrrFY
Application 3: Battery manufacturing equipment improvement

Research from the department of Thermal Process Engineering at the Karlsruhe Institute of Technology has shown, that with use of greenTEGs sensors space resolved heat transfer coefficient in thin-film dryer can be determined. Such an approach helps improving the quality of electrode production drastically.

Q&A regarding thermal characterization of batteries using heat flux sensors is available on our website

<table>
<thead>
<tr>
<th>Downloads</th>
<th>gSKIN® Heat Flux Sensors Datasheet</th>
<th>gSKIN® Heat Flux Sensors Instruction Manual</th>
<th>Case Study: Battery calibration using heat flux sensors</th>
</tr>
</thead>
</table>

**Features**

- Ultra-high resolution of thermal energies and temperature differences
- Low invasiveness and thickness
- For space resolved measurements, SOC control, life-time observation and BMS
- All sensors with conductive heat flux calibration according to ISO 8301
- Applications: R&D, thermal optimization, energy efficiency, industrial monitoring of thermal properties

**Questions and Answers**

**Q&A: Thermal characterization of batteries using heat flux sensors**

- **What kind of data logger do I need for my measurements?**
  - For high resolution measurements, you need a data logger which can resolve at least 0.5 °C. For synchronized measurements (for example channel 1 cell voltage, channel 2 heat flux voltage measurement) it is often useful to plug the sensor to the A channel of the multichannel power circuit.

- **How do I mount the heat flux sensor?**
  - Important when attaching the sensor to the battery surface is optimal thermal connection. Therefore it is recommended cleaning the surface of the sensor and the battery with isopropyl alcohol. Then the sensor can be attached by either adhesive side sticky thermal tape, or by pressing the sensor to the surface using thermal paste or by gluing the sensor to the surface using thermally conductive epoxy. The sensor needs to be removed carefully. Do not pull at the flex print — it is better to remove the sensor by a blade and isopropyl alcohol.

- **Which sensor is better, the XM or the XP?**
  - This depends on the application. The advantage of the XM sensor is its smaller size of 1.64 x 1.59 mm, while the larger XP sensor has a higher resolution and can be obtained below 0.01/°C/m/s. We propose that you test both so you can find out which one is best suited for your application.

- **Can the sensor be used in water?**
  - We have done several experiments in deionized water without any problems. The highly accelerated stress tests at a humidity of 85% and a temperature of 125°C for 300h do not show any sensor degradation.

- **Could the sensor be used inside the battery?**
  - We do not have any experience with this kind of experiments yet. You can try to do tests at your own risk. However the sensor is very robust against chemicals. For this kind of experiment we suggest to seal the borders and the contacts of the sensors with chemically stable glue. If you need a longer flex print for insertion into the battery, just ask for an additional flex print. You can attach this flex print to the flex print of the sensor by using a solder paste, pressing the two contacts onto each other and sealing it with a safer glue from top. Please make sure that you seal the position of the connection also by chemical in-glue.

- **How are the sensors calibrated?**
  - The sensors are calibrated in a special measurement setup using NIST traceable thermal reference materials. For further information see: [http://www.basler.de/technische-daten/kontakte-und-kataloge/3637.htm#L3637](http://www.basler.de/technische-daten/kontakte-und-kataloge/3637.htm#L3637)

Please do not hesitate to contact us at info@greenTEG.com if you have any questions.
Resources at a glance:

(1) Case study: Battery calorimetry using greenTEG’s heat flux sensors

(2) Case study: Monitoring heat generation of batteries

(3) greenTEG Q&A Thermal characterization of batteries using heat flux sensors


Additional literature:

http://jes.ecsdl.org/content/149/8/A978.full.pdf


http://www.ethlife.ethz.ch/archive_articles/131017_li-ion-battery_per/index