**Electro Optical Components, Inc.**
5464 Skylane Boulevard, Suite D, Santa Rosa, CA 95403
Toll Free: 855-EOC-6300
www.eoc-inc.com | info@eoc-inc.com





greenTEG

# Thermal footprint measurements (entropy profiling) for quality and state of health determination of Li-ion batteries at real time charging

During charging and discharging Li-ions are intercalated or removed from the electrode. When no more space is available, the Li-ions undergo a phase transition, in order to intercalate more ions - as sketched in Figure 1 by the model of Rüdorff [1].

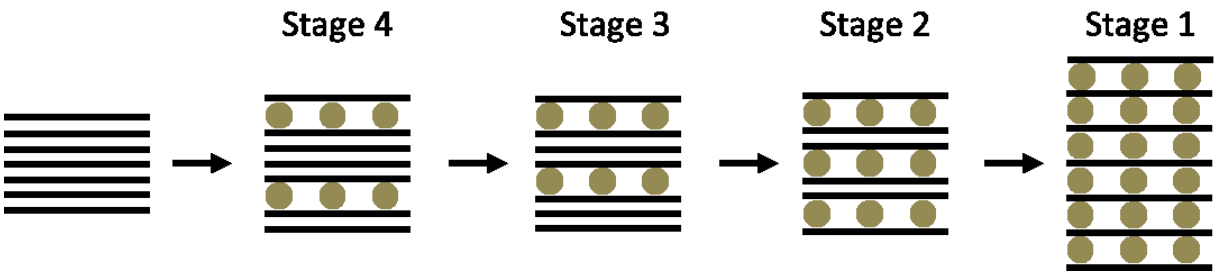


*Figure1 : Model of ion intercalation into graphite by Rüdorff [1]*

The same phase transitions also occur during discharging of the electrode. These transitions are accompanied by **thermal energy release or uptake**, which can be detected with greenTEG's Heat Flux Sensors (as shown in Figure 2).

Any change in the electrode or electrolyte quality is detectable by a shift of the peaks towards lower SOC values and/or by a reduction of the peak height. Therefore, monitoring of the features in the thermal profile leads to a very sensitive **determination of state of health** (as shown in the work of Yazami [2][a], or by the work of Kobayashi [3]), while from the comparison of the thermal footprints of new cells, **quality assessments can be done.**

[a] The work has been done with the common method for Entropy and Enthalpy determination, however this method takes up to 400h for the characterization of one cell, while entropy profiling with greenTEG Heat Flux Sensors can be done during normal charging/discharging of the battery.

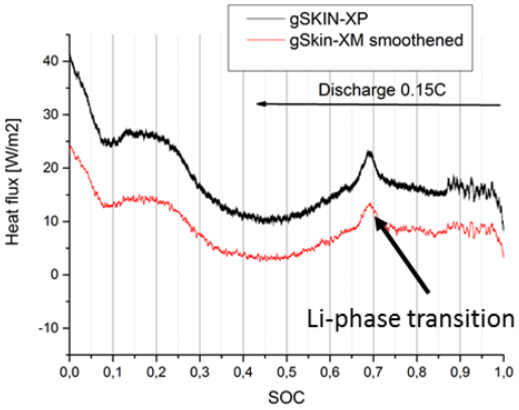


*Figure 2: Calorimetric footprint of a Li-ion pouch cell (Renata) during battery cycling at isothermal conditions recorded with two different heat flux sensors form greenTEG (gSKIN-XP and gSKIN-XM); left: measurement setup; right: measurement results*

Hence, entropy profiling is a powerful tool for:

- Battery quality determination (**End of Line testing**)
- State of Health determination
- Life time and aging investigation (**Second Life**)
- Electrode and electrolyte research
- Electrode disbalancing correction

If you have any questions regarding your application, please contact:

**Lukas Durrer,** Dr. | Co-Founder| R&D
---
**greenTEG AG**
PFA J27 | Technoparkstrasse 1 | 8005 Zurich, Switzerland
tel. +41 (0)44 632 54 28
lukas.durrer@greenTEG.com

*References*

*[1] W. Rüdorff, Journal of Physical Chemistry, (1940) , 45, 42*
*[2] K. Maher and R. Yazami, Journal of Power Sources vol. 261 (2014), 389 - 400*
*[3] G. Kobayashi et al., Journal of The Electrochemical Society vol. 149 issue 8 (2002), 978-982*