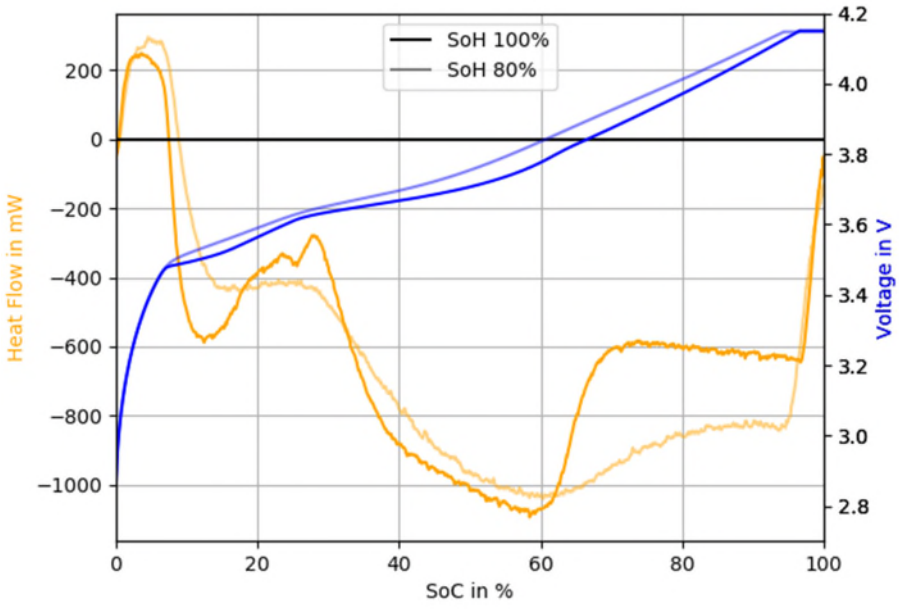
Thermal investigation of battery heat production and aging using an isoperibolic calorimeter

Michael Steeb[1], Simon Riedel[1], Stefan M. Sarge[2], Wilhelm Tegethoff[1], Jürgen Köhler[1]
[1] *Institut für Thermodynamik, TU Braunschweig, Hans-Sommer-Str. 5, 38106 Braunschweig, Germany*
[2] *Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany*
m.steeb@tu-braunschweig.de

The heat production within a lithium-ion battery is an important factor regarding both operational safety and the overall state of health (SoH). Due to the layered internal structure of the cell and its additional components it is further necessary to identify temperature differences within the cell to account for local “hotspots” leading to additional stress in these areas. Oftentimes a thermal management system is needed to keep the battery within defined temperature boundary conditions during operation to prevent accelerated aging or even a thermal runaway. It is therefore necessary to know the thermal behaviour of a cell during typical operation points to develop a suitable thermal management concept and ensure maximum battery life and safety.

In this work an isoperibolic calorimeter similar to [1] is built to measure the heat production of large format pouch cells developed for usage in modern electrified vehicles. It uses spatially distributed thermoelectric generators (TEGs) based on the Seebeck-effect to accurately determine not only the total heat production of the cell but also the local heat flow through the individual TEGs during operation. Identifying the thermal and electrochemical behavior at various operation points defined by varying charge/discharge currents and thermal boundary conditions it is possible to determine the dominant heat production mechanisms like joule heating and reversible entropy change. Comparing these heat production mechanisms for cells with varying SoH the effect of aging can be investigated [2]. Furthermore, a simulation model of the calorimeter setup is built to investigate the effects of varying thermal resistances for example due to the anisotropic thermal behavior of the cell itself or thermal contact resistances to verify the accuracy of the measured data.



References:
[1] Sarge, S.M.; Durmaz, I.: A scalable calorimeter for the thermodynamic investigation of pouch type electrochemical cells. 16th Symposium on Modeling and Experimental Validation of Electrochemical Energy Technologies, Braunschweig, 12.-13. März 2019.
[2] Murashko, K.; Li, D.; Danilov, D. L.; Notten, P. H. L.; Pyrhönen, J.; Jokiniemi, J.: Applicability of Heat Generation Data in Determining the Degradation Mechanisms of Cylindrical Li-Ion Batteries. J. Electrochem. Soc. 168 (1), S. 10511. 2021