Calorimetric Method for Accurate Determination of Heat Capacity of Lithium-Ion Battery Cells

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Lithium-ion batteries are the state of the art in various applications like smartphones, tablets, notebooks and nowadays also in electric vehicles. Although this technology is the most suited means for energy storage compared to other technologies, being more suitable than many other energy storage technologies, there is still much ongoing research and development to make lithium-ion batteries even better. High requirements are, for example, improving the aging behavior and safety of batteries. Both these properties are highly dependent on the temperature of the battery cell.
To understand the electrochemical and thermal processes of such batteries and to improve battery properties, simulations have been done. Depending on the modeling technique and the type of model, the heat capacity of a battery is, especially for thermal models, an import battery parameter. When the chemical components and composition along with their specific heat capacities are known, the heat capacity of the whole cell can be calculated. Often such data are kept secret by the battery cell manufacturer, and therefore the heat capacity cannot be calculated. For that reason, a battery calorimeter is developed and built in this work (see figures 1 and 2).
With the battery calorimeter, the direct measurement of the heat capacity is possible and no data on cell components and composition is necessary. Furthermore, the heat generation of the battery, because of the self-heating process due to the current load, can be measured. This work describes the experimental setup as well as the method of measuring the heat capacity. The results are compared to the theory of evaluation according to Regnault and Pfaundler [1]. This work furthermore takes into account the uncertainty limits in the measurement and identifies the major influence factors.

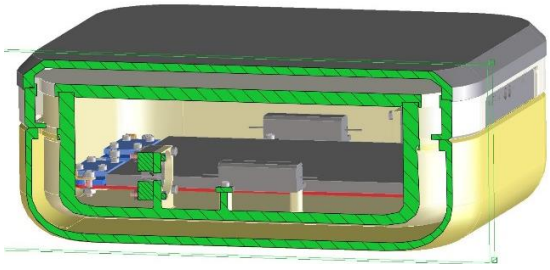

Figure 1: Battery calorimeter CAD model (sectional view)

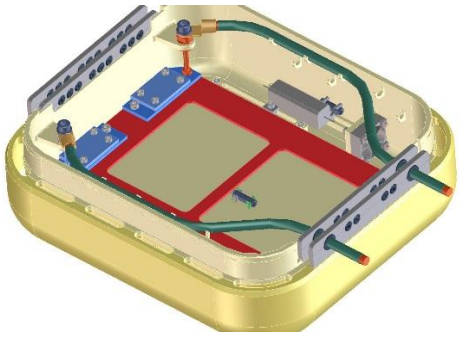

Figure 2: Battery calorimeter CAD model (inside view)

References:

[1] W.A. Roth, F. Becker, Kalorimetrische Methoden zur Bestimmung chemischer Reaktionswärmen, Heft 12 der Sammlung Verfahrens- und Meßkunde der Naturwissenschaft, Vieweg & Sohn, Braunschweig, 1955.