Combined electrochemical – thermodynamic investigations of lithium ion batteries

Carlos Ziebert, M. Rohde, Hans J. Seifert
Karlsruhe Institute of Technology,
Institute for Applied Materials (IAM-AWP)
Karlsruhe, Germany

Quantitative data on thermal response and heat generation during charging and discharging of lithium ion batteries are important input for the design of thermal management systems and operating life time determination. In this work, commercial lithium ion cells of different dimensions and capacities from different manufacturers were tested to investigate simultaneously their electrochemical performance and thermal behavior. In view of their applications in stationary energy storage as well as for electromobility, the cells were studied under isoperibolic and adiabatic conditions, respectively. Tests under adiabatic conditions are important as they simulate extreme battery operating environments. An Accelerating Rate Calorimeter (ARC) combined with a battery cycler was used for the combined electrochemical – thermodynamic measurements. The isoperibolic investigations were performed at environmental temperatures in the range from 20 to 80°C. The results show that different environmental temperatures did not significantly influence the general thermal battery behavior. Overall exothermic behavior for discharging half cycles and overall endothermic behavior for charging half cycles were observed in some cases. However both cycles consist of endothermic and exothermic parts. The total temperature increase over several half cycles was not very significant. For the adiabatic measurements a significantly different thermal behavior was found: The results showed exothermic behavior for both charging and discharging half cycles and a rapid temperature increase already from few cycles. Additionally, heat generation during cycling was derived and by using potentiometric measurements and current interruption technique it was possible to separate reversible and irreversible contributions to the heat generation.