Electrochemical-calorimetric studies on safety fundamentals of lithium ion battery pouch cells

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The thermal response of lithium ion batteries under charging and discharging conditions are important for both operating life determination as well as for safety. In this work, commercial lithium ion pouch cells of different dimensions and capacities from different manufacturers were tested to investigate their performance and their thermal behavior. In view of their application in stationary energy storage as well as for electric vehicles (EV) and hybrid electric vehicles (HEV) the pouch cells were investigated under isothermal conditions and adiabatic conditions, respectively. Tests under adiabatic conditions are important as they more accurately simulate the actual operating environment. An Accelerating Rate Calorimeter (ARC) with a battery cycler was used for the investigations.

The isothermal investigations were performed at specific temperatures in the range from 20 to 50°C. The results show that the applied environmental temperature did not greatly influence battery thermal behavior. Generally, an overall exothermic behavior for discharging half cycles and an overall endothermic behavior for charging half cycles was observed. However both consist of endothermic and exothermic parts. The total temperature increase over four half cycles was less than 2°C. For the adiabatic measurement a completely different behavior was found (Fig. 1). The results showed exothermic behavior for both charging and discharging half cycles and the total temperature increase over four half cycles was more than 15°C.

Additionally, the enthalpy change of each half cycle was calculated and by using potentiometric measurements and current interruption technique it was possible to separate the reversible and irreversible part of the heat generation.

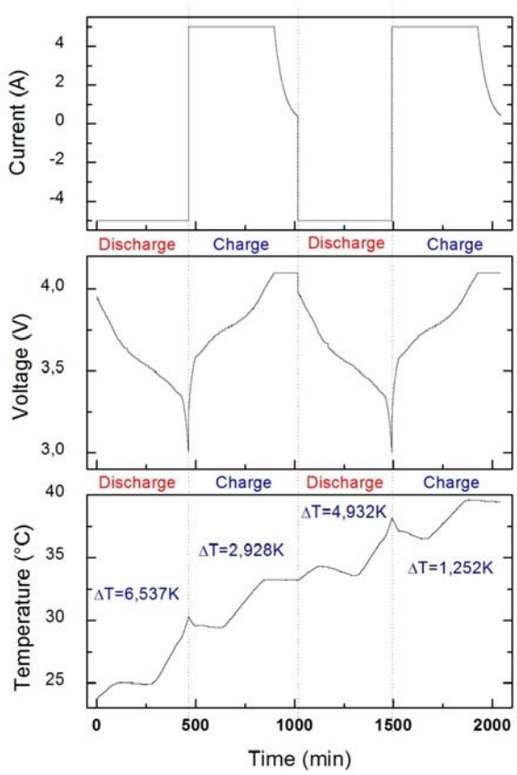

Fig. 1: Adiabatic cycling of a 40Ah pouch cell.