German Aerospace Center (DLR)

Institute of Engineering Thermodynamics

Development of Tests for Lithium-Ion Cell Characterization

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INTRODUCTION

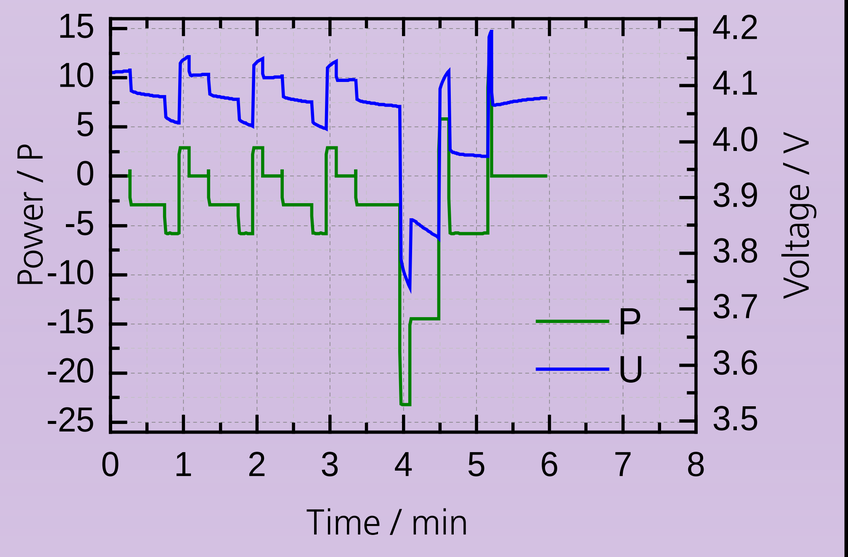
The long-term degradation behavior of lithium-ion batteries is directly related to changes in the internal resistance of the cells. Reasons for the increase in resistance are i.e. growth of insulating surface layer, electrolyte decomposition, loss of active material, blocked intercalation and delamination effects.
Commercial cells were aged by utilizing realistic load profiles. The internal resistance was investigated by the classic current pulse method (DIN EN 62660-1) as well as electrochemical impedance spectroscopy (EIS) in CGR18650 cells. First results of both measurement were in good agreement.

EXPERIMENTAL

Test procedure

– Cell (Type A) was aged with the load profile defined in DIN EN 62660-1
– Cell used: CGR18650

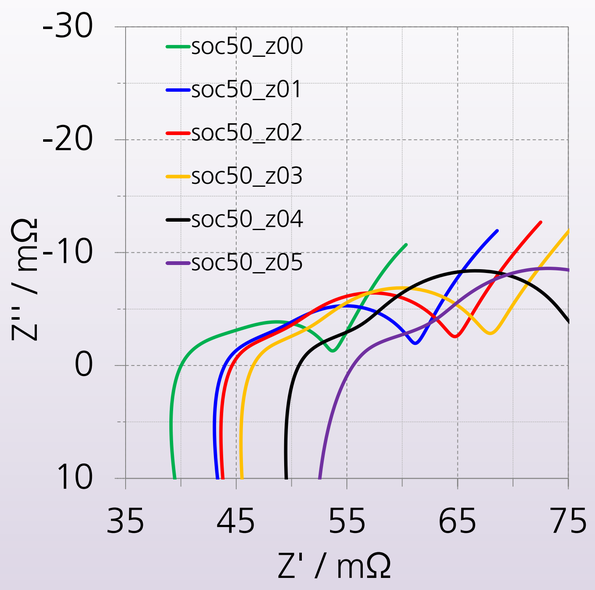
1) Cell was discharged (acc. to data sheet)
2) Cell was charged (acc. to data sheet)
3) Cell was discharged with dynamic load profile shown below until the capacity reached a value of 50 % of the initial capacity



4) Cycling continues for 28 days
5) Dynamic measurement of the discharge capacity and performance behavior
6) Performance behavior was additionally measured with electrochemical impedance spectroscopy (EIS)

EXPERIMENTAL RESULTS

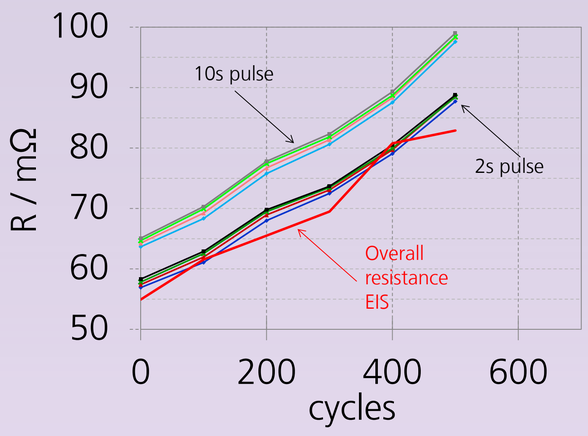
Degradation behavior measured with EIS



- Impedance spectra were recorded after 28 days (1 cycle)
- Spectra were recorded at constant SOC = 50 %
- Different degradation mechanisms (anode, cathode, electrolyte) were evaluated
- An increase in the ohmic resistance was detected as a result of cell degradation
- The total resistance $\sum R_i$ was calculated and compared to the resistance obtained with the pulse method

Degradation behavior measured with the pulse method

- Pulses of 2 s and 10 s in charge and discharge mode were applied
- Degradation behavior was measured every 28 days
- Comparison of the total resistance obtained with the pulse method and that obtained with EIS were in very good agreement
- In contrast to the pulse method the influence of battery components can be distinguished with EIS



CONCLUSIONS

- Degradation behavior of CGR18650 cells was evaluated with EIS and the pulse method according to DIN EN 62660-1
- The results obtained with both methods were in very good agreement
- The advantage of a characterization by EIS is the possibility to evaluate the different performance loss mechanisms (anode, cathode, electrolyte, etc.)
- A strong increase in the ohmic cell resistance is the main indicator of cell degradation.

ACKNOWLEDGMENTS

We thank the German Federal Ministry of Education and Research (BMBF) for funding this work (FKZ: 03X4636B)

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