Lehrstuhl für Fahrzeugtechnik
School of Engineering and Design
Technische Universität München

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Master's Thesis

Impedance-Based Parameterization of an Electrochemical Battery Model for Plating-Free Fast Charging

Limited range and long charging times remain the main arguments against purchasing an electric vehicle. Fast-charging strategies that operate at the physical limit of the battery require electrochemical models that make the anode potential accessible as an indicator for lithium plating. Their usefulness, however, relies on the quality of the parameterization, as the anode potential cannot be measured directly in a full cell.

Within this master's thesis, an electrochemical battery model of a commercial lithium-ion cell shall be parameterized and optimized in several stages based on existing measurement data. First, the state of the art on GITT evaluation, plating detection using dynamic electrochemical impedance spectroscopy (DEIS), and the parameterization of electrochemical models is reviewed in a literature study. On this basis, half-cell measurements are evaluated, and the solid-state diffusion coefficient of both electrodes is determined.
Subsequently, the model's reaction kinetics are optimized based on DEIS results. The thermal model is then calibrated, and the overall model is validated. Finally, the validated model is integrated into an existing framework and prototypically deployed on a Raspberry Pi for fast charging.

The master's thesis comprises the following work packages:

- Literature review on electrochemical modeling, GITT evaluation, and DEIS plating detection
- Evaluation of half-cell GITT measurements to determine the solid-state diffusion coefficients
- Optimization of the reaction kinetics using DEIS data
- Calibration of the thermal model
- Validation of the overall model and assessment of the results
- Prototype deployment of the model on a Raspberry Pi for fast charging
- Written documentation and critical reflection of the results

The thesis shall document the individual work steps in a clear and structured manner. The candidate commits to carrying out the master's thesis independently and to declaring all scientific resources used.

The submitted thesis remains the property of the institute as an examination document.

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