Running Projects

Research subject of the Electrical Energy Storage group is computational battery and fuel cell technology. We are currently working on the following publicly-funded projects:

- *Model-based state-of-health diagnostics of lithium-ion batteries - LIBlife (Land Baden-Württemberg/EU, 12/2018-11/2020).* In this project we apply our know-how in mechanistic aging modeling of lithium-ion batteries to develop an application-oriented state-of-health diagnostics. The developed algorithms will be applied in the battery systems of industry partners.
- *Electrochemical pressure impedance spectroscopy for transport characterization in electrochemical cells – EPISTEL (DFG, 03/2018-02/2021).* In this project we develop novel dynamic methods for the diagnostics of PEM fuel cells.
- *Diagnostic battery and photovoltaics laboratory for energy issues of industry 4.0 – Enerlab 4.0 (BMBF, 02/2018-06/2019).* This extensive investment measure includes equipment for battery and photovoltaic cell investigations.
- *Simulation of mechano-electro-thermal processes in lithium-ion batteries – SiMET (DFG 04/2017-09/2021)* is a research training group for PhD students in the field of lithium-ion battery simulations, taking place in collaboration with Karlsruhe Institute of Technology. We work in the fields of ageing modeling and impedance spectroscopy.
- *Modeling of pinted batteries.* PhD project in the framework of the cooperative graduate college *Modeling, Realization and Automatization of printed electronics* - MERAGEM (Land Baden-Württemberg, 09/2016-08/2019).
- *Prediction and extension of the lifetime of coupled stationary and mobile lithium-ion batteries* - STABIL (BMBF, 01/2016-12/2018). We investigate aging mechanisms and predict the lifetime of lithium-ion batteries, both on the cell level and pack level.
- *Lithium batteries with air electrode* - LiBaLu (BMBF, 01/2016-12/2018). In this project we develop models of lithium-air batteries. We use these model for design optimization of a demonstrator cell.
- *Lifetime of lithium-ion batteries for decentralized storage of renewable energies: Experimental investigations and model-based optimization.* PhD project in the framework of the cooperative graduate college *Decentralized Renewable Energy Systems - DENE* (Land Baden-Württemberg, 11/2014-10/2017). This projects investigates PV-coupled lithium-ion batteries with a particular focus on battery ageing and lifetime.

We have carried out the following terminated projects:

- *Stabilizing grid coupling of a local smart grid - Smart Link* (Elektrizitätswerke Mittelbaden, 09/2014-03/29016). We use energy system models of a smart microgrid with battery storage in order to develop grid-friendly operating strategies.
- *Optimization of charge protocols of a lithium-ion battery under specific consideration of the thermal behavior - TempOLadung* (BMBF, 11/2013-11/2016). In collaboration with the battery manufacturer Leclanché we develop optimized charge protocols for lithium-ion batteries. To this goal, we develop and apply a combined methodology of multi-scale modeling and experimental analyses.
- *Mechanism and design of precipitation of lithium oxides in lithium-air batteries - LiO2Mech* (BMBF, 01/2015-06/2016). This project funds the scientific and technological collaboration with USA. Together with Prof. Robert J. Kee (Colorado School of Mines) we develop models and simulation technologies for lihtium-air batteries.
- *Improvement of PEMFC performance and durability through multi-scale modelling and numerical simulation- PUMA MIND* (EU, 12/2012-12/2015, www.pumamind.eu). We investigate ageing mechanisms of PEM fuel cells for automotive applications. Computational fluid dynamic (CFD) simulations are being carried out on the cell and stack levels and are combined with microscopic degradation models in a multi-scale approach.
- *Thermal runaway of lithium batteries* (VolkswagenStiftung, 09/2011-10/2015). We develop combined deterministic and stochastic models of the thermal runaway of lithium-ion batteries. Heat production due to chemical side reactions (e.g., solid electrolyte interface decomposition) is coupled with heat transport and dissipation.
- *"Kommunaler Energieverbund Freiburg" - Demonstration of electrolysis in the industrial area Freiburg-Nord for connecting electricity and gas grids for storing renawable energies (Land Baden-Württemberg, 12/2013-06/2015). Within the work package "Modeling" we develop, in collaboration with Prof. Anke Weidlich (HS Offenburg), energy system models for optimizing the operation strategies of a smart microgrid with PV, electrolysis, fuel cell, and battery storage.*
- *Strom aus Luft und Li - Efficient bifunctional oxygen electrodes* (BMBF, 06/2011-11/2014). We model the electrochemical reactions and transport processes in the oxygen electrode of high-energy lithium-air batteries. The

electrode behavior (efficiency, capacity) is governed by complex spatially dependent solid product precipitation (Li_2O_2, LiOH).

- *Multi-scale modelling and in-situ diagnostics for SOFCs* (Helmholtz-Gemeinschaft, 01/2010-01/2015). We carry out combined modelling and experimental investigations of performance and lifetime of solid-oxide fuel cells, with a focus on understanding degradation mechanisms and developing in-situ laser diagnostic techniques.