Karlsruher Institut für Technologie

Institut für Angewandte Materialien
Elektrochemische Technologien
Adenauerring 20 b
76131 Karlsruhe

Bachelor thesis / Master thesis

Electrochemical analysis of catalyst degradation in low-temperature PEM fuel cells

Research area

- ☐ Batteries
- ☒ Fuel cells and electrolysis
- ☐ Electrocatalysis

Alignment

- ☒ Experimental
- ☒ Electrical Characterization
- ☐ Material analysis
- ☐ Development of measurement technology
- ☒ Modeling
- ☐ Simulation
- ☒ Literature Research

Course of study

- ☒ Electrical engineering and IT
- ☒ Mechanical Engineering
- ☒ Chemical Engineering
- ☐ Physics
- ☐ Techno mathematics
- ☐ Industrial Engineering

Language

- ☒ English
- ☒ German

Starting date

As soon as possible

Contact person

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Motivation

The development of sustainable energy sources is increasingly drawing attention to environmentally friendly mobility. PEM fuel cells offer a remarkable combination of high energy efficiency, low emissions and fast start-up times that meet the requirements of mobile applications. They convert hydrogen into electrical energy, generate only water vapor and thus reduce the ecological footprint.

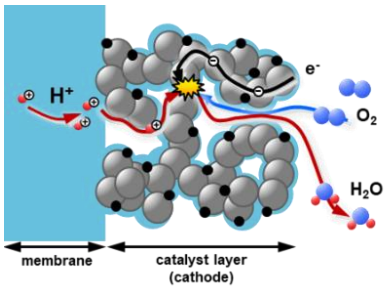

Fig. 1: Platinum catalyst layer of a PEM fuel cell

Extending the lifetime of PEM fuel cells is a challenging task, as the degradation of materials and the effects of operating conditions interact in complex ways. The balance between performance optimization and longevity requires innovative approaches to overcome this complex challenge. The focus here is on the platinum catalyst layer, which is crucial for both cost reduction and lifetime optimization.

The IAM-ET has several PEMFC test benches for the high-resolution characterization of PEM fuel cells. In combination with the evaluation methods established at the IAM-ET, it is possible to obtain physical insights into the loss processes taking place in the cell.

Areas of responsibility:

The aim of the work is the electrochemical analysis of catalyst degradation of PEM fuel cells during targeted degradation using accelerated stress tests (ASTs). For the electrochemical analysis, electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV) and polarization curves are used.

The work is divided into the following work packages

- Fundamentals of the PEM fuel cell, measurement methods and AST procedures
- Development, implementation and execution of ASTs as well as electrochemical in-situ analysis using EIS, CV and polarization curves
- Measurement data analysis using the distribution function of relaxation times (DRT) and chain ladder models (TLM) with a focus on catalyst degradation
- Analysis of the influence of different operating conditions on catalyst degradation

Application

We offer a lively atmosphere and the opportunity to work in an interdisciplinary team on an innovative topic. Interested candidates are asked to send a brief motivation letter, curriculum vitae and grades to the email address mentioned. Please contact Mr. Sebastian Raab for more detailed information.

Prof. Dr.-Ing. Ulrike Krewer