

# The Use of Operando Scattering to investigate the Degradation of Pt/C Fuel Cell Catalyst

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Proton exchange membrane fuel cell (PEMFC) powered vehicles are a promising alternative to combustion engines in the heavy-duty sector. For such applications extended lifetimes of the electrocatalysts are required. To study the degradation behavior of PEMFC catalysts typically accelerated stress tests (ASTs), simulating driving conditions are applied and the response of the catalyst is investigated. Local methods such as high-resolution transmission electron microscopy (HR-TEM) provide information of the degradation on a local scale<sup>1</sup>, however, often several different degradation mechanisms occur. To investigate the overall behavior of the catalysts, therefore integrative methods such as small- and wide-angle scattering (SAXS and WAXS) are preferred. Furthermore, these techniques can be applied operando, i.e., during the AST. In the presentation, I will present our work on operando SAXS/WAXS degradation studies<sup>2,3</sup> and highlight advantages, but also the challenges in coupling these techniques to electrocatalytic measurements.

## References

- [1] - K.J.J. Mayrhofer et al., Fuel cell catalyst degradation on the nanoscale. *Electrochem commun* **10**, 1144-1147 (2008).
- [2] - J. Schröder, R.K. Pittkowski, M. Arenz, J. Du & J.J.K. Kirkensgaard, Investigating the Particle Growth in Bimodal Pt/C Catalysts by In-Situ Small-Angle X-ray Scattering : Challenges in the Evaluation of Stress Test Protocol-Dependent Degradation Mechanisms Investigating the Particle Growth in Bimodal Pt/C Catalysts by. *J Electrochem Soc* **169**, 104504 (2022).
- [3] - J. Schröder et al., Tracking the Catalyst Layer Depth-Dependent Electrochemical Degradation of a Bimodal Pt/C Fuel Cell Catalyst: A Combined Operando Small- and Wide-Angle X-ray Scattering Study. *ACS Catal* **12**, 2077-2085 (2022).