

***Ex situ* testing method to characterize cathode catalyst  
degradation during start-up/shut-down -  
A contribution to PEM Fuel Cell benchmarking**

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**Abstract**

The paper introduces a novel *ex situ* test procedure that was developed to quantify the ageing of catalyst layers under critical automotive fuel cell conditions during start-up/shut-down phases. It is based on liquid electrolyte measurements, using a thin film catalyst electrode. The overall degradation under start-up/shut-down conditions is assessed by the decay in electrochemically active surface area. Furthermore, contributions from different processes leading to catalyst degradation such as Pt dissolution and Pt particle growth/agglomeration can be separated. Finally, using a differential electrochemical mass spectrometry (DEMS) set-up, also the extent and role of carbon corrosion under these conditions is accessible. The potential of this, compared to *in situ* fuel cell stack tests, rather fast and less costly *ex situ* test procedure is demonstrated in measurements using a commercial, graphitized carbon supported Pt catalyst. The results of the degradation test and in particular the contributions from different degradation processes such as Pt dissolution, Pt particle growth/agglomeration and carbon corrosion during different stages of catalyst ageing are discussed.

**Keywords:** *Fuel cells, electrochemical testing method, startup/shutdown, degradation mechanism, testing standard, carbon corrosion.*

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