

Anode aging in polymer electrolyte membrane fuel cells

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Degradation of polymer electrolyte membrane fuel cells (PEMFC) is investigated through an accelerated stress test (AST) consisting of load-induced humidity cycling combined with open circuit voltage. This combined stressor-AST was designed to closely mimic the stress conditions that the FC faces under real operating conditions [1]. During the AST, commercially available membrane-electrode assemblies (MEA) with an initial voltage of about 0.7 V at 0.5 A cm² showed a performance drop of about 900 μV/h. Their operation was followed by monitoring various parameters such as polarization plots, electrode electrochemical surface area, hydrogen permeation and electrochemical impedance spectra [2]. The results demonstrate that, although the anode may be initially ignored to model the impedance data, this is no longer possible during the AST (Figure) since it has an impact on fuel cell impedance. This means that it becomes possible to monitor its ageing while performing AST. Experimental data show that, beyond classical cathode and membrane degradations, the cell undergoes pronounced anode degradations, confirmed by post mortem analyses, that significantly affect the cell performances. Local potential measurements excluded the anode degradation to be linked to electrode potential cycling, which remained always between 0 and 0.2 V vs. reference hydrogen electrode. Classical mechanisms of Pt/C degradation [3] may thus not be at stake here, but rather mechanical destabilization of the anode microstructure under wet-dry cycling. The temperature elevation at high current density, known to entail local membrane dehydration may be an aggravating factor.

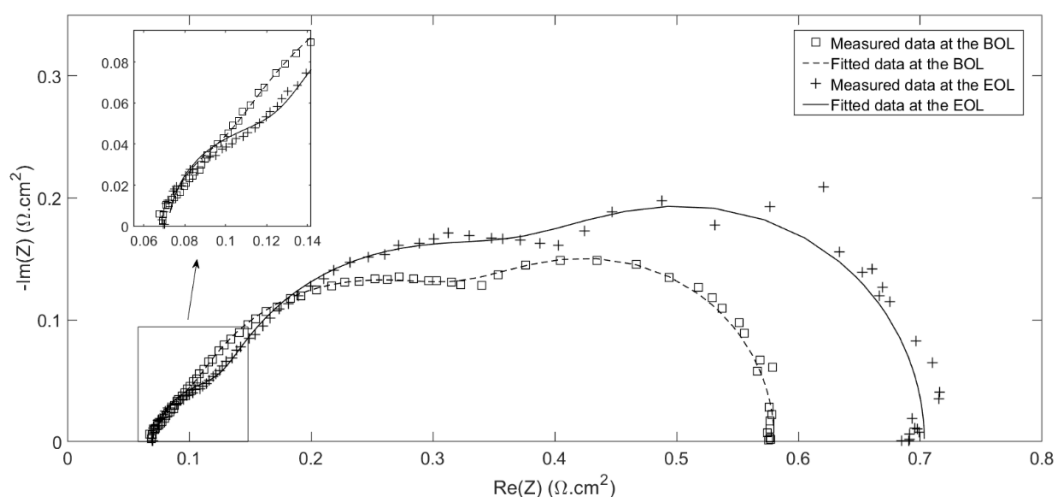


Figure: impedance spectrum of a pristine and an aged MEA after 240 h of the ageing protocol application, measured at 0.5 A/cm², with frequencies varying from 20 mHz to 10 kHz.

References:

1. Lai, Y.-H. *et al.* Accelerated Stress Testing of Fuel Cell Membranes Subjected to Combined Mechanical/Chemical Stressors and Cerium Migration. *J. Electrochem. Soc.* **165**, F3217–F3229 (2018).
2. Touhami, S. *et al.* Anode aging in polymer electrolyte membrane fuel Cells I: Anode monitoring by ElectroChemical impedance spectroscopy. *J. Power Sources* **481**, (2021).
3. Dubau, L. *et al.* A review of PEM fuel cell durability: Materials degradation, local heterogeneities of aging and possible mitigation strategies. *Wiley Interdiscip. Rev. Energy Environ.* **3**, 540–560 (2014).