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Local *in-operando* measurement of the protonic resistance of PEMFC electrodes and membranes

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This work focuses on the development of electrochemical impedance spectroscopy (EIS) methods to measure the protonic resistance of PEMFC active layers. Experimental spectra of a cathode fed with nitrogen (H_2/N_2) are fitted to a volumetric electrode impedance model [1], [2] to yield the protonic resistance of the electrode and that of the membrane in controlled humidity conditions.
In addition, EIS measurements are performed on a cathode fed with oxygen (H_2/O_2), delivering current and producing water. The protonic resistances of the membrane and of the electrode are obtained in several conditions of gas stoichiometry and of current density. The effective humidity within the membrane and within the electrode are estimated using the calibration obtained in controlled humidity conditions.

As an illustration of the validity of the technique, the case of a cell operated with dry oxygen at the cathode is studied. Thus, the monitoring of a MEA self-humidification is achieved with spatial resolution using a segmented cell designed in our lab. It is compared to the cases of fully humidified gases and of partially humidified gases. In all tested conditions, the effective humidity is higher within the cathode than within the membrane. In dry oxygen conditions, most of the cathode is fully hydrated, except for the segments located close to the air inlet.

This work paves the way for a better understanding of water management. It is to the best of our knowledge one of the first attempts to measure the effective humidity within the catalytic layer, and within the membrane *in-operando*.

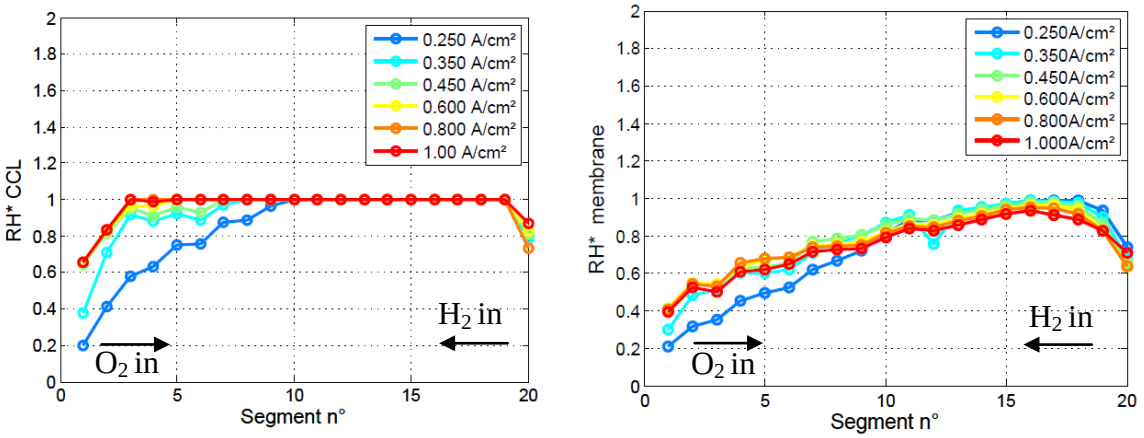

*Figure 1: Profiles of effective humidity within the cathode catalyst layer (a) and within the membrane (b). Measurement performed with a linear segmented fuel cell with 50%RH H_2 and **8%RH O_2** stoichiometries 2/10 respectively T=80°C, P=1.5bar.*

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