ME1496_ Quantification of water content in electrode of proton exchange membrane fuel cell with µSAXS

Experimental report

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The main objective of this experiment was to quantify the swelling of the ionomer within the electrode of a PEMFC during operation using µSAXS with an energy of 13 keV. We have been able to record the SAXS spectra within the membrane, the anode and the cathode of the fuel cell at different relative humidity and under operation thanks to a dedicated cell that has been designed at CEA. We did observe evolution of the spectra with the relative humidity associated to change in the nanostructure of the ionomer induced by water swelling, both in the membrane and in the electrodes. The contribution of the Pt nanoparticles to the spectra makes the analysis difficult. However, microstructural characterization carried out at CEA by TEM allows us to know the particle size distribution in the CL. From this distribution, the SAXS scattering pattern due to Pt nanoparticles has been calculated and substracted from the total signal. After this data treatment a well-defined peak appears on the spectra. It is attributed to the ionomer swelling (Figure 1). Indeed, its position and evolution with relative humidity corresponds to what is measure by SANS or SAXS for bulk material. We did observe a swelling of the ionomer when water is produced (Figure 1). Thus, we have validated the feasibility of the method to characterize the ionomer swelling within the electrode in-situ and *in operando*. Caution must be taken because of the damaging induced by the beam. We checked that no evolution of the crystalline structure of the ionomer is observed after several measurements of 5 ms. But the total counting time must not exceed 50 ms at the same location.

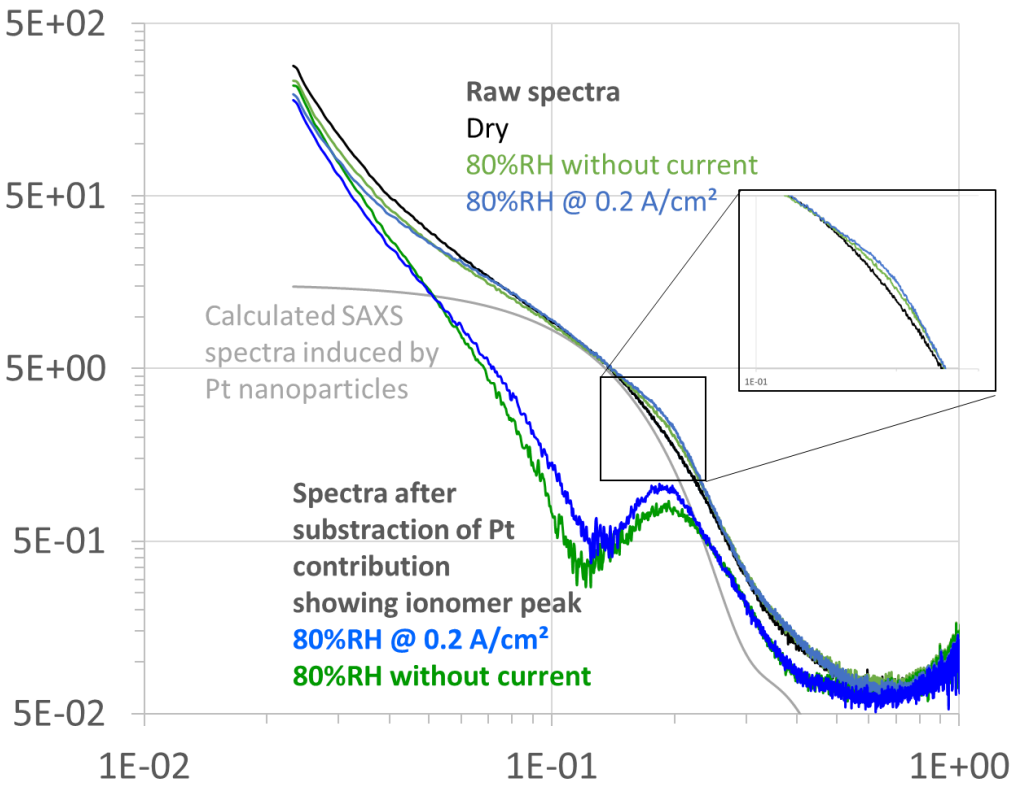

Figure 1. SAXS spectra obtained in operating fuel cell, before and after subtraction of the contribution of the Pt nanoparticles.

Improvements must be done on the cell in order to be able to operate it at higher temperature and pressure, that is to say in more representative operating conditions. We expect to publish the preliminary results before 2020.