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Nafion membrane water dynamics by in-situ time-resolved X-ray diffraction on running PEMFCs

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Abstract A non-standard approach, based on the use of very high energy X-ray diffraction, was applied to measure the water content in the Nafion membranes of a PEM Fuel Cell. The technique was applied *in-situ* to gain the hydration degree in the polymeric membrane of the FC devices in real working conditions. The study explores the new the possibilities offered by the direct observation of the water dynamics in relation to various operative conditions of the cell.

One of the major problems in enhancing the performances Proton Exchange Membrane Fuel Cell (PEMFC) devices lies in the water management inside the PEM, since proton transfer in such polymeric materials is known to be assisted by water. On the other hand, only a few experimental techniques[1] are available to measure the membrane water content and distribution, due to the intrinsic difficulties to monitor the water molecules inside a thick membrane assembled in an operating device.

By this approach, the problems associated to the *in-situ* measurements in a real device, which imposes strict geometric constraints, are bypassed using the very-high energy (about 90 keV) synchrotron radiation diffraction (VHEXD) available at the ESRF ID15 beamline[2, 3]. In such a way, the time-dependence of the Nafion membrane hydration degree in any experimental condition in which the FCs may operate can be obtained.

In the present work, the problem of the competitive mechanisms producing the overall hydration (water production at the cathode, humidity transported by the supplying gases) or dehydration (evaporation due to heat production, drying effect of the gas fluxes) of the membrane is addressed.

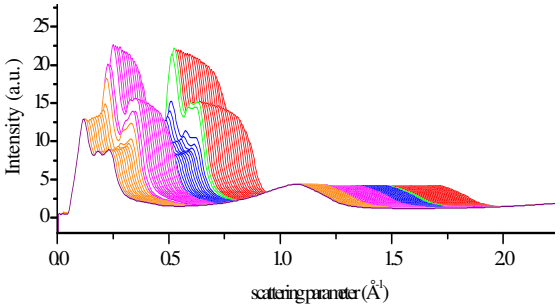

Figure 1. Time-resolved VHEXRD results

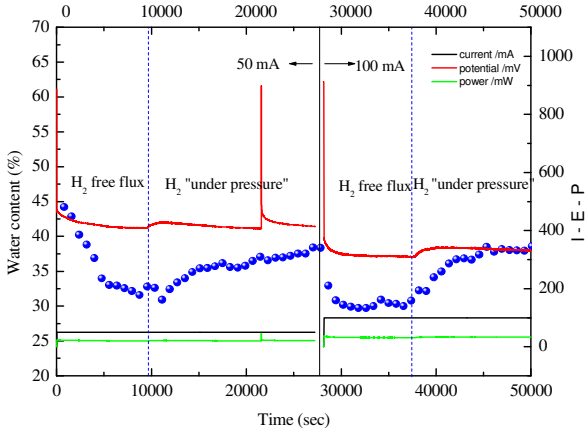

Figure 2: PEM water content. vs. time curve

References

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[3] V. Rossi Albertini, B. Paci, F. Nobili, R. Marassi, M. Di Michiel, *Advanced Materials*, 2008, DOI: 10.1002/adma.200801652