Experimental report

28/01/2021

Proposal: 1-04-175 **Council:** 4/2019

Title: Probing the evolution upon aging of ionomer nanostructure in fuel cell electrodes using SANS

Research area: Materials

This proposal is a new proposal

Main proposer: Arnaud MORIN

Experimental team: Arnaud MORIN
Fabrice MICOUD
Sandrine LYONNARD
Gerard GEBEL
Florian CHABOT
Florent VANDENBERGHE
Philippe CLEMENT
Laurent JACQMIN
Sebastien ROSINI

Local contacts: Lionel PORCAR

Samples: C + (CF2)17SO3H

Instrument	Requested days	Allocated days	From	To
D22	4	7	30/01/2020	04/02/2020
			15/09/2020	17/09/2020

Abstract:

Automotive with very low pollutants emission powered by a PEMFC are now commercially available. Increasing the durability of this system is a prerequisite to make it really cost competitive against existing technologies. However, the degradation phenomena of the components of the membrane electrode assembly (MEA) are still not well described. Especially, despite its major role, the evolution upon aging of the proton conducting polymer (ionomer) within the electrode has not been studied because of the lack of relevant technics available at the laboratory scale.
The aim of this proposed experiment is to study the ionomer structure and swelling properties in-situ and during operation of one fresh and two samples aged in different conditions of humidity. Operando investigation of the structure of the ionomer within very thin electrode (30 µm) requires to record SANS spectra in a broad range of Q (0.005 to 5 A-1) with a highly collimated beam and a dedicated 10 µm x 8 mm slit. Thus, a very high neutron flux, a high resolution diffractometer and a well-controlled sample environment (temperature) are needed. The feasibility of the experiment has been previously demonstrated.

Final report 1-04-175

From 30/01/2020 to 04/02/2020 AND From 15/09/2020 to 17/09/2020

Probing the evolution upon aging of ionomer nanostructure in fuel cell electrodes using SANS

Morin Arnaud, Florian Chabot, Fabrice Micoud, Sandrine Lyonnard, Gérard Gebel, Sylvie Escribano.

Automotive with very low pollutants emission powered by a PEMFC are now commercially available. Increasing the durability of this system is a prerequisite to make it really cost competitive against existing technologies. However, the degradation phenomena of the components of the membrane electrode assembly (MEA) are still not well described. Especially, despite its major role, the evolution upon aging of the proton conducting polymer (ionomer) within the electrode has not been studied because of the lack of relevant technics available at the laboratory scale.

The aim of this proposed experiment was to study in-situ and during operation the evolution of the ionomer structure and swelling properties in the electrode before and after aging.

As planned, we installed the whole setup and started the measurements in-situ in order to determine the swelling law of ionomer by recording reference spectra at room temperature as a function of relative humidity (RH) from 50% to 100%RH. Because of the small size of the beam, we were facing difficulties in alignment and we were obliged to change the cell. We started the Operando measurements. Unfortunately, the reactor stopped because the water level was too low in the Drac River. We lost close to one day and the experiment restarted only 10 hours before the end of the experiment. So, this was not possible to complete the experimental plan. Since the experiment requires complex setup with a fuel cell test bench, we had 2 days re allocated in September 2020.

Finally, we did conduct measurements on two samples aged following two types of stress tests. The spectra were recorded at different RH and current densities with H_2 and D_2 to vary the contrast. We evidenced on the spectra difference in swelling behavior of the ionomer and in electrode nanostructure (Figure 1). Data are still under analysis.

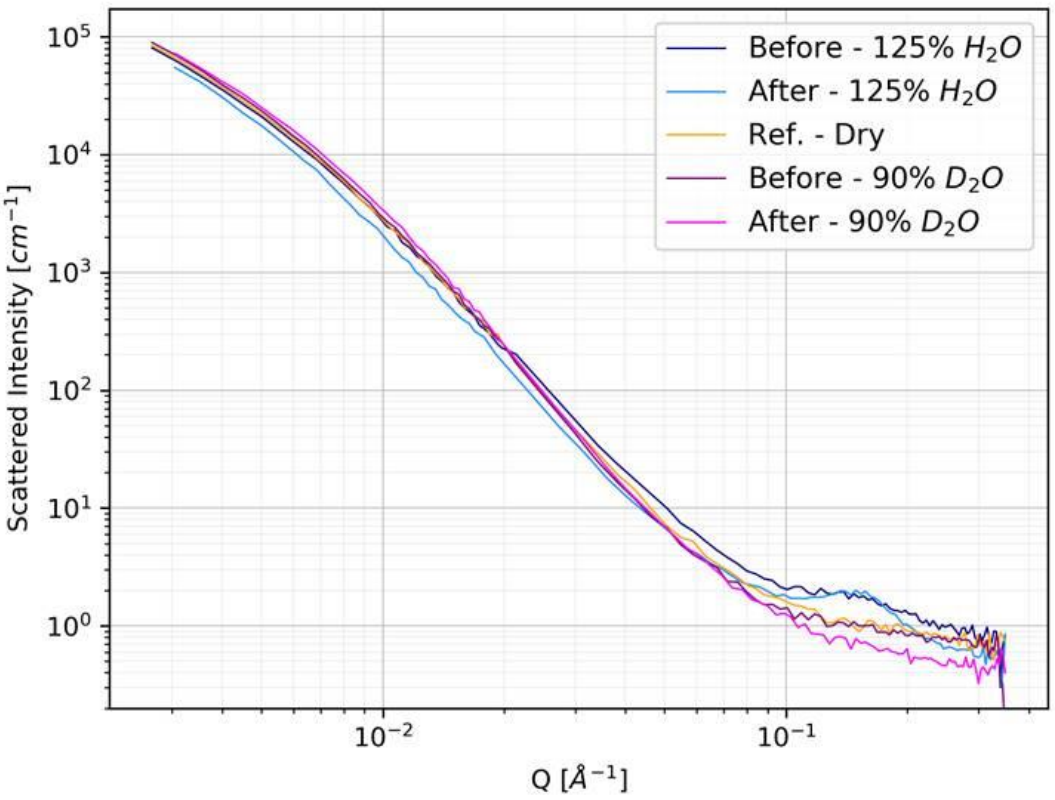

Figure 1: SANS Spectra of fuel cell electrode obtained in-situ before and after aging