In-Situ characterisation of gas diffusion layers of polymer electrolyte fuel cell

S. Chevalier[a], A. Bazylak[a]
[a]Thermofluids for Energy and Advanced Material Laboratory, Department of Mechanical & Industrial Engineering, Faculty of Applied Science & Engineering, University of Toronto, Toronto, Ontario, Canada
schevali@mie.utoronto.ca

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The gas diffusion layer (GDL) of polymer electrolyte fuel cell (PEFC) is one of the most studied components due its high impact on fuel cell performance. The porous design of the GDL is essential. The void region is needed to facilitate the diffusion of gaseous species and the removal of the reactant products (gas and liquid water), whereas the solid is used as an electrical and thermal conductor. The efficiency of these phenomena depends on the GDL properties which must be characterised in detail in order to tailor its structure for optimal performance. Most of the works done in the last couple of decades have been focused on the characterisation of these materials in ex-situ environments [1]. However; in in-situ conditions, the GDL is subjected to thermal and mechanical stresses under several coupled phenomena. Thus, going forward, GDL properties must be characterised in-situ.

For the last decade, several groups [2, 3] have demonstrated the suitability of X-ray radiography to study in-situ liquid water dynamics in the PEFC. Based on the Beer-Lambert law, the liquid water thickness can be measured through the GDL, see figure 1.(b). Moreover, coupled with the classical PEFC characterisation tools such as electrochemical impedance spectroscopy (EIS) or polarisation curves [4], correlations between the liquid water dynamics and fuel cell performance can be found.

In this communication, we will present a new in-situ method to characterise the GDL effective diffusivity, based on three coupled experimental techniques. EIS spectra were recorded to measure the effective diffusivity, figure 1.(a). While at the same time, 2D radiography of liquid water thickness through the GDL was performed using X-ray imaging. Then, the structure of our compressed GDL was obtained from micro-computed tomography (figure 1.(c)), which provided the through plane distribution of liquid water saturation and porosity. Finally, we propose new GDL effective diffusivity values correlated to the local GDL water saturation and porosity, all of which were measured in-situ.

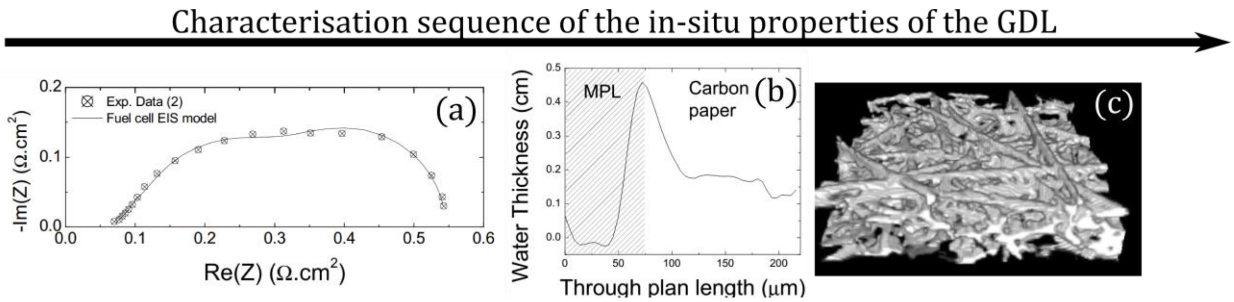

Figure 1. (a) Measure of the effective diffusivity by EIS. (b) In-situ liquid water saturation measured by X-rays synchrotron imaging. (c) 3D GDL structure characterized by micro-computed tomography.

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