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New methodology developments based on electrochemical noise analysis of PEMFC

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Recently, there is an active research and developments applied to new energy sources. One of the most perspective systems on electricity production is the proton exchange membrane fuel cell (PEMFC). PEMFC is potentially beneficial for a wide range of applications, thanks to its attractive advantages, such as high efficiency, high power density, zero greenhouse gases emissions, and low temperature range 50-80°C operation. However, there are still two barriers: the reliability and durability, which imped the wide application of PEMFC. Fault diagnostics can be an efficient solution to overcome these barriers. In this field, method based on informational properties of electrochemical noise is promising. Indeed, it allows developing a diagnostic of the system without perturbation in operation mode. In frame of the present work, electrochemical noise analysis (ENA) was applied to study the effect of the relative humidity and current density in a single PEMFC cell. It has been found that diagnostic features can be extracted by the power spectral density (PSD) and short time analysis of the FC electrochemical noise. The PSD of electrochemical noise versus frequency for fuel cell (FC) operated under constant current mode (8 A) is presented in Figure (1a). It was revealed that in low frequency range (f<100 Hz) the PSD highlighted a linear slope of α=2 for all relative humidities except RH=20/20. When the membrane is under dry conditions (RH=20/20), PSD shows a different signature with slopes behavior divided in three parts (α=1.63, 3.98 and 1.82). Under flooding or drying conditions, short time analysis shows an explosion of the noise due to inoperative conditions. In conclusion, ENA is very sensitive to changes of operating conditions of the FC and can be a powerful tool for the detection of an incorrect water balance (drying and flooding).

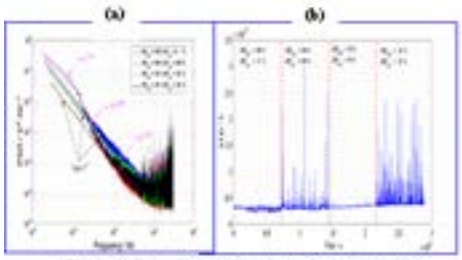

Fig. 1. (a) Power Spectral Density vs frequency and **(b)** Short time analysis for different humidities at I = 8 A.

Recent Publications:

1. R Maizia, A Dib, A Thomas and S Martemianov (2017) Proton exchange membrane fuel cell diagnosis by spectral characterization of the electrochemical noise. Journal of Power Sources 342:553-561.
2. R Maizia, A Dib, A Thomas and S Martemianov (2017) Statistical short-time analysis of electrochemical noise generated within a proton exchange membrane fuel cell Journal of Solid State Electrochemistry 22:1649.
3. B Legros, P X Thivel, Y Bultel and R P Nogueira (2011) First results on PEMFC diagnosis by electrochemical noise. Electrochemistry Communications 13:1514–1516.

Biography

Anthony Thomas has his expertise in heat, mass transfer and charge transfer applied to electrochemical systems (fuel cell, battery). His metrology developments based on temperature sensors and electrochemical noise analysis generated descriptors that help the diagnostics of these systems.

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