Experimental methods for the diagnosis of PEMFC stacks

S.Wasterlain [1], F.Harel [2], D.Candusso [2], D.Hissel [1], X.François [3], P. Moçotéguy [4]

1,2,3 ➔ Institut FC LAB, Techn'Hom, rue Thierry Mieg, 90010 BELFORT Cedex, FRANCE.
1 ➔ FEMTO-ST (UMR CNRS 6174), ENISYS department, University of Franche-Comté.
2 ➔ INRETS, The French National Institute for Transport and Safety Research.
3 ➔ UTBM, University of technology Belfort Montbéliard.

4➔ EIFER, European Institute for Energy Research, Emmy-Noether Strasse 11, 76131 Karlsruhe, Germany.

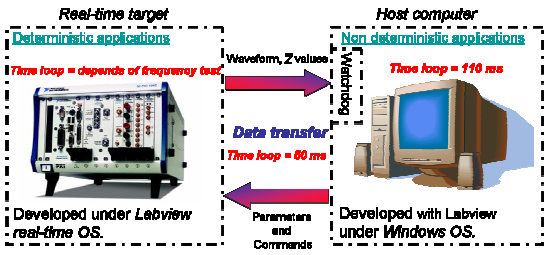
Objectives:

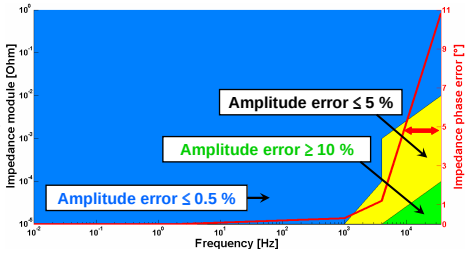
❖ **Development of new methods to improve the lifetime expectancy of Fuel Cell system :**

➢ **Development of a high-voltage and multi-cell diagnostic tool for the measurement of impedance spectra.**
➢ **Application of Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV) on Fuel Cell stack.**

Experimental results:

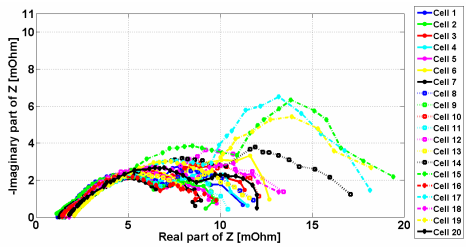
❖ Impedancemeter principle :

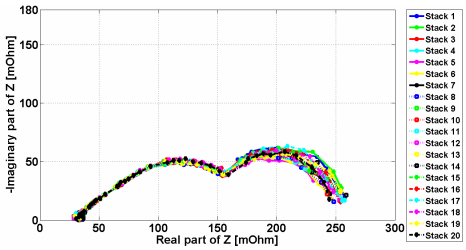




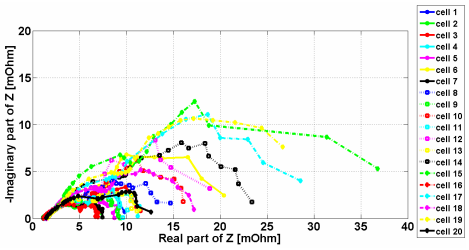
✓ **Common potential mode 300 V,**
✓ **Voltage acquisition up to 300 V,**
✓ **Current acquisition up to 450 A,**
✓ **32 acquisition ways (1* I + 31* U),**
✓ **High precision DAC (26 bits),**
✓ **Good accuracy of the system (excepted for low impedance values coupled to a high frequency range),**
✓ **F. bandwidth (6.7 mHz to 10 kHz),**
✓ **Cost ~ 20 k€.**

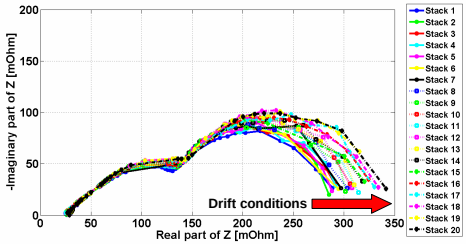
❖ Impedancemetry results :





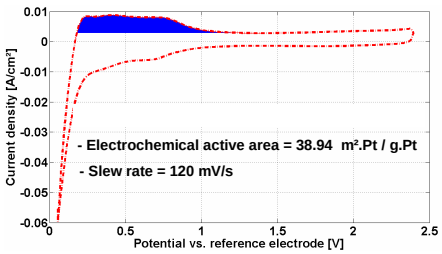
✓ **I= 15 A and T= 30° C, dried conditions,**
✓ **Simultaneous acquisition of one cell and stack spectra,**
➔ **Stack impedances are close and do not depend on time parameter (which allows cell impedance comparison),**
➔ **Large dispersion in cell impedance spectra due to stack design and cell position.**

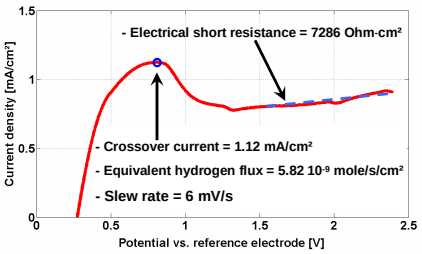




✓ **I= 25 A and T= 40° C, dried conditions,**
➔ **Unstable conditions : stack impedances change with acquisition time (cell comparison is not possible),**
➔ **Larger dispersion in cell impedance spectra due to stack design, cell position and set of parameters.**

❖ Voltammetry experiments :





Experimental details

✓ **3 cell stack,**
✓ **T= 25° C, HR_{air}= 90%, HR_{H2}= 35%,**
✓ **Umin = 50 mV ; Umax = 2.4 V,**
➔ **Determination of the true electrochemical active area,**
➔ **Determination of the membrane state of health (permeability of the membrane to hydrogen molecules).**

FC LAB
Systèmes pile à combustible

Institut FC LAB
90010 Belfort Cedex - France
Tél. +33 (0)3 84 58 36 00 - fax +33 (0)3 84 58 36 36 - www.fclab.fr