Advanced Metrology Developments applied to Proton Exchange Membrane Fuel Cell

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In the background of the energy demand, primarily based on hydrocarbons, that irreparably increases; hydrogen, if it produced in a safe and renewable way, appears as a viable energy source for the future. Combined with the proton exchange membrane fuel cell (PEMFC), it can provide electricity and heat energy without local greenhouse gas emissions. Although PEM fuel cells are currently being marketed, many scientific and technological aspects should be clarified and optimized to achieve a sustainable development. The two biggest barriers are durability and cost.

To improve the cost and durability as well as the performance of a multiphysic system such as PEMFC, we have developed experimental metrology and methodology to understand mechanism within the fuel cell system. We combined fluid, thermal and electric metrology within the assembly of a PEMFC to provide rich descriptors of the physical transfers to diagnose, monitoring and improve the fuel cell operation. Tests have been performed with an adequate use of a fluidic (water balance) and thermal (platinum microwires inserted at the electrode) metrology. These simultaneous measurements have revealed the influence of temperature gradients on the water transport within the stack [1].

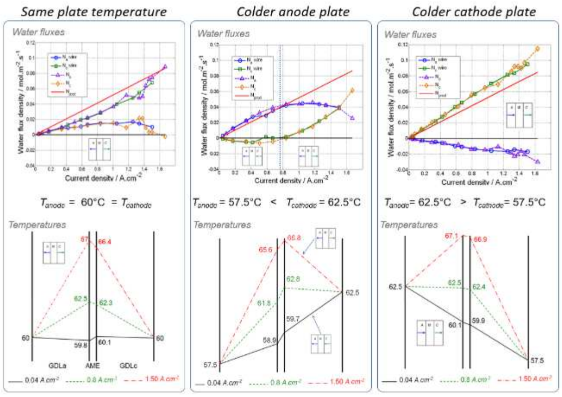

Figure 1: Water transport by thermal gradient in a fuel cell

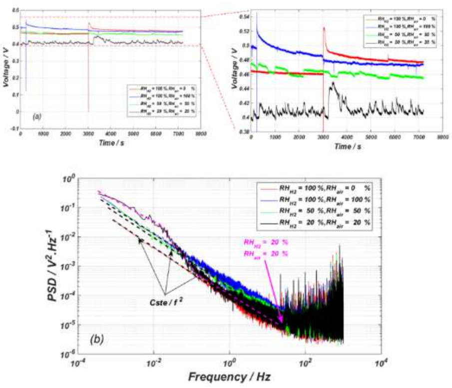

Figure 2: ENA of fuel cell for different humidities

Electrical metrology development based on high speed voltage fluctuations measurements (electrochemical noise analysis - ENA) have been developed to provide accurate descriptors for the diagnosis and prognosis of a PEMFC single cell and stack. ENA was applied to study the aging of an 8 cells hydrogen PEMFC stack in an automotive application.

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