FUEL CELL MATERIALS DEGRADATION IN STACK CONFIGURATION

R.A. Silva, M.A. Travassos, T.I. Paiva, C.M. Rangel*

Laboratório Nacional De Engenharia e Tecnologia Industrial
Fuel Cells and Hydrogen Unit
Paço do Lumiar, 22 1649-038 Lisboa Portugal

carmen.rangel@ineti.pt

Even though the numbers of installed units around the world continue to increase and dominate the pre-markets, the present lifetime requirements for fuel cells cannot be guarantee, creating the need for a more comprehensive knowledge of material's ageing mechanism.

PEM fuel cell operates under very aggressive conditions in both anode and cathode and the mechanisms of fuel cell degradation are not well understood. Failure modes and mechanism in PEM fuel cells include those related to thermal, chemical or mechanical issues that may constrain stability, power and lifetime. The application of a full range of diagnostic techniques and modelling is felt necessary in order to aid design and operating strategies in PEM fuel cells.

Diagnostics methods and tools used for in-situ and ex-situ analysis of PEM fuel cells are discussed in order to better categorize irreversible changes in the kinetic and/or transport properties of the cell after fuel cell ageing in extreme testing conditions will be discussed.

In this work, the case of fuel starvation is examined in a low power fuel cell stack. The anode potential may rise to levels compatible with the oxidization of water. If water is not available, oxidation of the carbon support will accelerate catalyst sintering. Electrochemical Impedance Spectroscopy (EIS) is found instrumental in the identification of fuel cell flooding conditions and membrane dehydration associated to mass transport limitations / reactant starvation and protonic conductivity decrease, respectively. Cross sections of the membrane catalyst and gas diffusion layers examined by scanning electron microscopy indicate electrode thickness reduction as a result of ageing. Catalyst particles are found to migrate outwards and located on carbon backings.

Membrane degradation in fuel cell environment is analysed in terms of the mechanism for fluoride release which is considered an early predictor of membrane degradation. Peroxide radical attack generated from hydrogen peroxide during the oxygen reduction reaction is thought to be on the basis of extensive fluorine loss.