MATERIALS DEGRADATION MECHANISMS IN AN OPEN CATHODE LOW POWER PEM FUEL CELL

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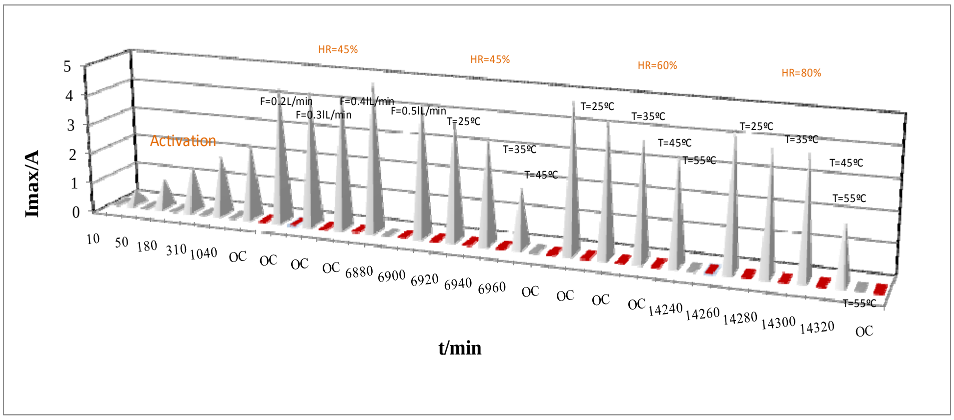
In this work, a low power PEM fuel cell intended for passive management of water was operated integrating a range of relative humidity (RH) from 30 to 80% and temperatures from 5 to 55ºC. An open air cathode, provided with an excess air stoichiometry condition, was designed for easy water removal and stack cooling. The 4 cell stack was fed with pure hydrogen and uses own design flow field drawn on graphite plates from Schunk and a commercial MEA with carbon supported catalyst containing 0.3 $mgcm^{-2}$ Pt.

Full stack characterization was made using a purpose-built test station and a climatic chamber with temperature and RH control. Results indicated that 60% RH is associated to maximum performance on the fuel cell under study over the studied temperature range. While water management is done in a passive fashion, heat management is accomplished on the basis of the injection of air at the cathode with the fuel cell showing good performances at relatively low currents where back diffusion towards the anode is favored.

Fig.1. Maximum current during activation, characterization and cycling of a low power 4 cell open cathode PEM stack vs time (partial view). OC: open circuit



The loss of performance with temperature increase is related to an increase in the membrane resistance which may correspond to loss of water on the anode side. Performances at temperatures lower that room temperature showed only slight decrease in power. An examination of the fuel cell components after 50 h of operation (~650 h life time) revealed cathode failure associated to catalyst migration anomalies favored by operation conditions that allowed platinum particles to break free from their carbon backing and migrate to the polymer electrolyte. Migration resulted in precipitation with larger mean particle size distribution within the solid electrolyte when compared to the original catalyst layer, rendering a very significant loss of thickness in the cathode material. Coarsening of platinum particles occurs at nano and micro-scale. The possibility of carbon corrosion is also examined. The mechanism for the lost of catalyst by dissolution and growth is discussed on the basis of a joint electrochemical, SEM and TEM study.