INFLUENCE OF DOUBLE HYDROPHILIC/HYDROPHOBIC MICROPOROUS LAYERS ON PEMFCS PERFORMANCES

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In recent decades Polymer Electrolyte Membrane Fuel Cells (PEMFCs) have attracted scientific community attention for use as power sources in mobile and stationary applications due to low related emissions and high power densities reached [1-2]. Water management in a PEMFC is a crucial factor affecting performances [3]. MicroPorous Layer (MPL), which is coated onto the carbon fiber-based Gas Diffusion Layer, is a hydrophobic layer with several micro-pores that serve to improve water removal and gas permeability. Indeed, MPLs have been recently employed to reduce mass transport limitations, which are due to water flooding, and to improve performances, especially in the high current density region [4]. Currently, the MPL is made from dispersion of carbon black and PTFE particles in different concentrations [5]. In this work, carboxymethylcellulose (CMC) was introduced in the formulation as a viscosity and stability controller. In a typical experiment, carbon black powder was mixed with an appropriate amount of PTFE, a surfactant, water and then CMC was added in different amounts. Several concentrations of CMC were employed (from 0.25 % wt to 2% wt) and rheological measurements of the inks were performed. All the inks were stable, pseudo-plastic and shear-thinning, thus being suitable for blade coating deposition onto GDL. Two different depositions were adopted: a single layer with CMC and a double layer with a first hydrophobic layer without CMC and a second one containing CMC. The coated samples were calcined up to 350 °C for 30 min. Scanning Electron Microscopy was used to evaluate coatings and to measure thickness. A relationship between inks viscosity and thickness of the coated layers was found: the higher the viscosity, the thicker layers are. Contact Angle measurements were performed in order to assess hydrophobicity of the prepared MPLs: all the samples are hydrophobic with contact angles variable from 130° to 155°. Electrochemical performances of the samples were tested in a single cell experiment with an active area of 25 cm^2; Nafion 212 was used as electrolyte. Hydrogen and air were used as the anodic and cathodic feedings, respectively. Polarization and power curves showed a better performance when the cell was assembled with double layer MPLs that were able to manage water production in high current densities conditions, while single layer MPLs based cell showed a sudden drop of voltage. The best results were reached with a very low amount of CMC (0.25 % wt).

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