Numerical Modeling of Polymer Electrolyte Fuel Cell Catalyst Layer with Different Carbon Supports


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The Monte Carlo simulation method is used to carry out numerical modelling of the polymer electrolyte membrane fuel cell (PEMFC) catalyst layer with a random catalyst particles distribution in a polymer matrix. The approaches of mass transport and electrochemical kinetics are applied for estimation of potential distribution and current generation in the catalyst layer. It is shown that large particles of the catalyst support (agglomerates of nanofibers) provide percolation for electron transport at a lower concentration in comparison with compact catalyst support particles (i.e. Vulcan XC-72R). Mixtures of such supports also have a lower percolation threshold. It gives the possibility to increase polymer concentration, stabilise water balance and decrease ohmic losses for ion transport in the catalyst layer. The numerical estimations demonstrate the possibility of precious metal loading reduction up to 30% and the increase of performance (current density) up to 20% just due to addition of carbon nanofibers in the catalyst layers. In the experimental study we reached an increase of PEMFC current density for about 10% when we used the Vulcan XC-72R supported Pt catalyst together with the Pt catalysts on nanofibres

Keywords: Catalyst Layer, Numerical Simulation; Polymer Electrolyte Fuel Cell; Percolation, Pt Based Electrocatalysts, Catalyst Supports.

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