In this paper, the bipolar plates of thin metallic PEM fuel cells are fabricated by electrochemical micro-machining (EMM). The reaction area is 4 cm^2. The dimensions of width and depth of two different bipolar plates, 500 μm, 200 μm and 300 μm, 300 μm, are fabricated. In order to understand the performance and reaction variation of the thin fuel cells, the cell performance tests and electrochemical impedance spectroscopy (EIS) are used to analyze the cell performance and impedance variations. By the results of the impedance tests, the effects of gas flow, water produce and transport of the cell could be evaluated. Comparing the results of impedance and performance tests, the better design of the thin metallic bipolar plate could be obtained.

Keywords: electrochemical impedance spectroscopy, metallic bipolar plates.

[P38]

Heat and mass transfer effects in a direct methanol fuel cell: A 1D model

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Models play an important role in fuel cell development since they facilitate a better understanding of parameters affecting the performance of fuel cells and fuel cells systems. In this work, a steady state, one-dimensional model accounting for coupled heat and mass transfer, along with the electrochemical reactions occurring in the DMFC is presented. The model accounts for the kinetics of the multi-step methanol oxidation at the anode while the kinetics of the cathodic oxygen reduction is modelled using the Tafel equation. Two-phase flow effects are neglected. The anode and cathode flow channels are treated using the continuous stirred tank reactor (CSTR) approach. The cell voltage expression incorporates the anodic and cathodic overpotentials as well as the ohmic losses across the membrane. The mixed potential of the cathode due to methanol crossover is also included. The reactions in the catalyst layers are considered homogeneous. Pressure gradients across the layers are assumed as negligible. Methanol and water transport through the membrane is assumed to be due to the combined effect of the concentration gradient and electro-osmotic force. Mass transport in the diffusion layers and membrane is described using effective Fick models. Local equilibrium at interfaces is represented by partition functions. The methanol flux in the cathode catalyst layer is considered as well as methanol crossover. The transport of heat through the gas diffusion layers is assumed to be a conduction-dominated process. The thermal conductivity for all the materials is assumed to be constant. Heat generation is considered in the catalyst layers. The analytical solutions for concentration and temperature across the cell are compared with recently data existing in literature and with in-house obtained results, for a wide range of operating conditions. The model shows very good agreement. This easily implemented simplified model is suitable for use in real-time DMFC simulations.

Keywords: Direct methanol fuel cell, modelling, heat and mass transfer, thermal effect

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Behavioural patterns of LTPEMFC and HT PEMFC over 1200 hours of operation

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The performance of LT PEMFC (with a PFSA based membrane) and HT PEMFC (with a PBI-H_3PO_4 based membrane) in comparable cells of 50 cm² over a period of 1200 hours has been investigated. Both cells were operated with hydrogen and air without humidification, with a load current of 200 mA/cm². Polarization curves have shown that degradation rates were comparable in both cases. Results of product water analysis made, in both the cases are discussed in the paper.

The electrical, mechanical and chemical properties of the graphite-compound based bipolar plates were analysed at the beginning of life (BOL) and at the end of life (EOL). SEM images of the bipolar plates at BOL and EOL are presented in the paper.