SP-I-6

A MODIFIED NAFION MEMBRANE WITH IN-SITU POLYMERIZED POLYPYRROLE FOR THE DIRECT METHANOL FUEL CELL

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Introduction The Nafion (Dupont) membrane has shown very good performance in the Polymer Electrolyte Fuel Cell, however, in the Direct Methanol Fuel Cell exists the problem of crossover of methanol from the anode to the cathode side, leading to a reduced performance of the cell. In this project we aim to synthesize a thin layer of polypyrrole inside the nanopores of the existing Nafion membrane, in order to prevent the diffusion of the methanol.

Experimental Pretreated Nafion 117 membranes were immersed in an sulfuric acid electrolyte containing the pyrrole monomer and subsequently placed in a two-electrode sandwich-type cell between stainless steel electrodes, where the polypyrrole was formed galvanostatically and in-situ on the anode side only. The modified membranes were studied in terms of morphology, conductivity, electrochemical characteristics and methanol permeability. Electrochemical experiments were performed in the same sandwich type cell, though in 3-electrode set-up, between carbon paper electrodes, with a thin strip of carbon paper functioning as reference electrode.

Results FTIR results (figure 1) confirm that polypyrrole was indeed deposited on the anode side only, as can also be seen from SEM micrographs. Cyclic voltammetry (figure 2) of membranes previously immersed in methanol shows, besides the typical peaks of polypyrrole oxidation and reduction, additional peaks at high current density. These high current densities were not seen for samples after immersion in sulfuric acid, suggesting a possible effect of the polypyrrole present in the membrane on the oxidation of methanol. Such an additional catalytic effect of the conductive polymer, would aid to reduce the crossover of methanol. We will further present results on electric and ionic conductivity as studied using AC impedance spectroscopy and results for methanol permeability.

Conclusions In-situ polymerization of polypyrrole in Nafion membranes might offer a solution to the problem of methanol crossover in the Direct Methanol Fuel Cell. Further studies are needed.

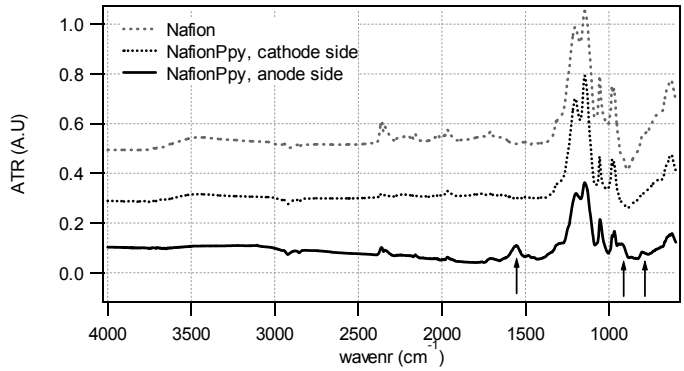

Figure 1. FTIR spectra for unmodified Nafion 117 and modified Nafion-polypyrrole (both anode and cathode side) membranes. Typical Ppy peaks are indicated with arrows.

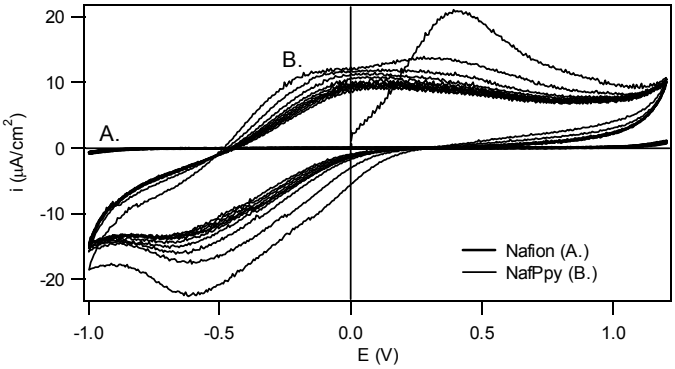

Figure 2. Cyclic voltammogram of unmodified Nafion 117 (A.) and modified Nafion-polypyrrole (B.) membranes in methanol at 50 mV/s.