NAFION-mesoporous silica as electrolyte for ethanol fuel cells

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A direct alcohol fuel cells is a device which use alcohol directly without any further modification. Ethanol is an attractive alternative to methanol, it is less toxic renewable and relatively cheap. On the other hand, as in the case of methanol, the ethanol crossover through the polymer electrolyte membrane reduce the efficiency of the fuel cells. So many composite materials was then studied to overcome some of this problem.

Some previous work was conducted to enhance the water retention of Nafion® and related membranes by incorporating transition metal oxide particles, such as SiO_2, obtaining promising results. Antonucci et al. [1] studied a silica composite membrane for direct methanol fuel cell application and they attributed the enhanced performance of the composite membrane to the hygroscopic properties of silica. Watanabe et al. [2] investigated silica and titania impregnated Nafion® composite membranes They reported that the silica particles were superior to titania particles in terms of water-retention qualities within the Nafion® membrane and attributed this effect to the higher water sorption properties of silica. Nishiyama et al [3] studied the possibility of the use of mesoporous materials for fuel cells application, they reported that the ordered structure of pores seem to contributed to the high proton conductivity of the system.

In this work, a mesoporous silica was synthesized and characterized, to be used as a filler for commercial NAFION with the aim to reduce the ethanol cross over and to increase the thermal stability and the water retention. We expect also the organized porous structure of the mesoporous silica to be suitable for the migration of protons in the polymer matrix at relatively high temperatures.

Mesoporous silica (MPS) was prepared by the sol gel method in presence of a triblock copolymers with the trade name Pluronic (BASF Corp., USA). Pluronic F127 (Mw=12600, EO99PO69EO99). types was used as a surfactant.

The N_2 adsoprtion-desorption isotherms of the silica exhibit type IV-like isotherms, typical of ordered mesoporous materials with a sharp inflection at $P/P0 \approx 0.5$ (type H_2 hysteresis) as shown in Figure.1. The surface area was analyzed by the BET (Braunauer, Emmet and Teller) method. The BET surface area data of the silica samples after the removal of the templates was about 428 $m^2\ g^{-1}$.

Membrane with 5%.wt in silica was then cast using commercial NAFION solution. and pretreated before the electrochemical characterization.

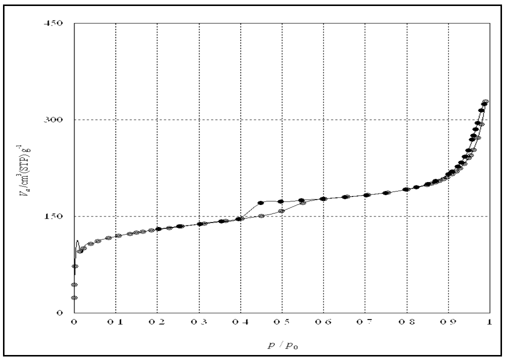

Figure 1 Nitrogen adsoprtion-desorption isotherms of synthesized silica.

The first conducted polarization curve on this material, with 2 mol/L ethanol loaning (2 mL/min) at 80°C (figure 2), show that the composite have a similar behavior of the pure NAFION membrane with an increase on the open circuit voltage (0,685 for NAFION and 0,71 for the composite) witch indicate an decreasing of the ethanol crossover.

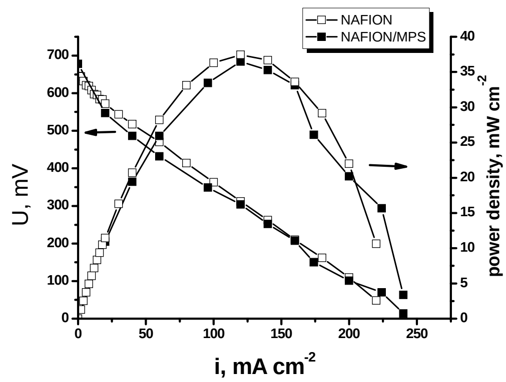

Figure 2 polarization curves and power density curves for NAFION/MPS (solid symbols) and NAFION cast membrane (open symbols).

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[3] Y. Nishiyama, K. Ochi, N. Nishiyama, Y. Egashira, and K. Ueyama, Electrochemical and Solid-State Letters, 11 (1) B6-B9 2008.