Characteristics of Polyprrole/Nafion Composite Membranes in a Direct Methanol Fuel Cell

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Direct methanol fuel cells (DMFC) are advantageous over a hydrogen/air fuel cell because of its much simpler system design (i.e. liquid fuel, no reformer). However, using methanol as a fuel creates several new challenges. Methanol oxidation kinetics are complicated. Also, a Pt/Ru co-catalyst is required in order to prevent CO poisoning.

Another issue is that methanol can crossover the Nafion membrane from the anode side to the cathode side. This not only wastes fuel, but also poisons the cathode catalysts, thereby decreasing the cathode (and cell) performance.

Similarly, water also readily crosses the membrane. A dilute aqueous methanol feed is used at the anode therefore a large amount of water crosses the membrane and can cause flooding at the cathode. Higher cathode performance can only be achieved by employing high airflow at elevated pressure[1].

To combat these issues, we have prepared polyprrole/Nafion composite membranes via an *in situ* polymerization of the pyrrole monomer. The impregnation of membranes, including Nafion, with polymers by *in situ* polymerization is well known[2,3] and some reports[4, 5]suggest the use of such composites as catalyst materials or supports for fuel cells. These composite membranes have been shown to significantly reduce methanol crossover[6]. Since it is difficult to selectively block methanol over water, it is believed that there is also a lower flux of water across these membranes.

Polyprrole/Nafion composite membranes have been prepared by many different modification methods (*i.e.* different oxidants, reaction times, and membrane thickness) and thoroughly tested in a DMFC. Their performances (anode, cathode and cell) and methanol crossover rates will be compared to those of unmodified Nafion membranes. Performances of each membrane are correlated with its ionic resistance and rate of methanol crossover. Variation in performance with temperature and airflow rate will also be discussed.

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