Electrode porosity considerations for DMFC's

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The pore space of a porous electrode is equally crucial to the electrode's performance as the electrochemical processes occurring at its surfaces. The pores in a direct methanol fuel cell (DMFC) anode, for example, must simultaneously distribute aqueous methanol to and permit transport of CO_2 gas away from the catalyst surface, while providing for a minimal concentration of methanol at the electrode-membrane interface.[1-3] The intent of this work is to optimize the electrode porosity and morphology in a DMFC to meet requirements for use as a portable power generation system; namely, high power density and maximum methanol utilization.

DMFC electrodes are typically prepared by bonding a catalyst layer, consisting of carbon-supported metal particles and Nafion© binder, onto a Nafion© membrane. A gas diffusion backing usually made of a porous carbon paper is placed on each side of the electrodes. The diffusion backing pores must provide efficient removal of the CO_2 gas from the anode and prevent flooding of the cathode. Cracks and holes in the catalyst layer may be introduced during electrode manufacture or membrane electrode assembly (MEA) production. Such imperfections are undesirable in the anode structure, since they allow high fuel concentrations to reach the surface of the membrane. Furthermore, a well-designed anode catalyst layer must have a pore structure which ensures that mass transfer restrictions will limit the cell current, since the operational current should approach the limiting current to achieve an optimized balance between kinetics and fuel crossover.[4]

In the present work, the morphology and pore size distribution of catalyst layers prepared on gas diffusion backings are studied using a variety of techniques, including scanning electron microscopy (SEM), gas adsorption, and Hg-porosimetry. The results are interpreted in terms of porosity phenomena relevant to fuel cell operation, such as: gas diffusion pores; catalyst-layer primary and secondary pores; cracks or holes in the catalyst layer; etc. Suggestions are made for optimizing the electrode morphology. We will also comment on the impact of tailoring pore-size and pore-distribution on the overall performance of a DMFC single cell.

References:

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