A New Water Management Approach using Absorbent Wicks for Polymer Electrolyte Fuel Cells

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Proper water management is vital to ensure good cell performance as the performance of a polymer electrolyte fuel cell (PEFC) is strongly dependent on the proton conductivity of the membrane and oxygen transport in the electrode. External humidification of the reactant gases is an effective way to avoid dehydration of the membrane. However, it needs humidification subsystem and a high humidity of reactant gases may lead to water flooding. The reactant humidification subsystem not only consume a considerable fraction of power, but also account for a significant part of cost, weight and volume. Recently, some methods for internal humidification of reactant gases were presented.[1-2] The problem of water distribution and transport in the cell operated with dry gases has been the object of several studies.[2-4]

A novel water management strategy for PEFC using different absorbent wicking materials was investigated. Fig.1 shows the serpentine flow field structure of the polar plate with and without two strips of polyvinyl alcohol (PVA) sponge. Through this technology, water produced by the electrochemical reaction is transported to the inlet region of the reactant gas and used to humidify the dry reactant gas on the cathode side. Membrane electrode assemblies (MEA) of 50 cm^2 were prepared using Nafion 112 membrane and electrodes containing 0.4 mg/cm^2 platinum. The catalyst layer consists of two layers. The first layer is hydrophobic with a weight ratio of Pt/C catalyst to PTFE of 9:1. The second layer is hydrophilic as there is no PTFE in it.

For the thin membrane used, the back-diffusion of water from the cathode to the anode is sufficient to humidify dry hydrogen and to prevent drying out of the anode in the counterflow mode. Fig. 2 shows the performance comparison of fuel cells with zero, one and two strips of PVA sponge. The cells were operated in the counterflow mode. While only one wick was used, it was mounted on the top of the cell. Due to an improved water distribution in the whole region of the cell, PEFC with two strip of PVA sponge can be operated without external humidification of the reactant gases and still outperform the common one without wicks operated with dry or saturated gases. The performance of the cell with PVA wicking materials was stable under high current density conditions (I=1.2 A/cm^2) and very little performance degradation was observed over a 120 hour investigation period when both dry hydrogen and dry air were fed.

References

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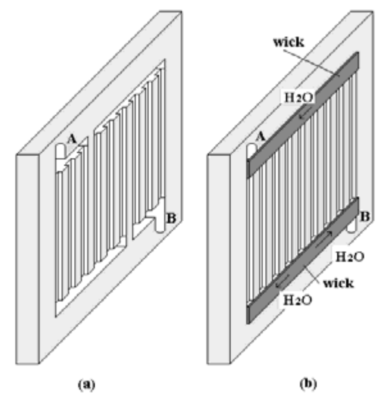

Figure 1. Schematic of the serpentine flow field structure without (a) and with (b) two strips of absorbent wicking material.

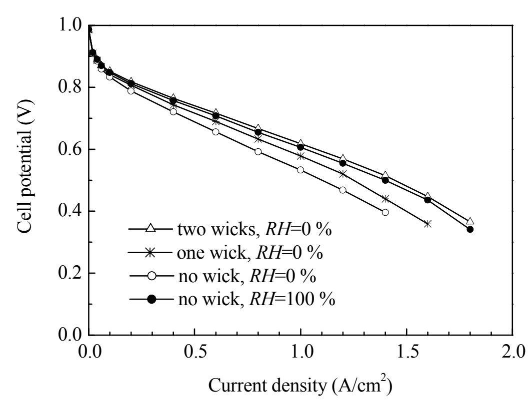

Figure 2. Performance comparison of the fuel cells with zero, one (top) and two strips of absorbent PVA sponge with H_2/air at different humidities (T=70°C, $p_{H2}=p_{air}$=0.3 MPa, $RH_{H2}=RH_{air}$, ξ_{H2}=1.2, ξ_{air}=2.0)