High Power Density PEMFCs With Thin Composite Membranes Operating Above 100 C

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Proton Exchange Membrane Fuel Cells are suitable power sources for portable, stationary and transportation applications. Higher efficiencies, low or zero emissions and fewer moving parts are the major advantages of PEMFCs over conventional power sources. The proton conducting membrane needs to be fully hydrated for attaining high power densities and thereby the operating temperature has been limited to below 100^0 C. Hydrophilic inorganic materials, incorporated in the membrane help retention of water at higher temperatures. In addition high temperature operation has the advantages of increased CO tolerance, simpler water and thermal management and faster electrode kinetics of the oxygen reduction reaction. While composite membranes with inorganic additives have been demonstrated successfully at Princeton University[1] and elsewhere at higher operating temperatures, loss of water from the membrane at under-humidified conditions is unavoidable. In the present work, thinner composite membranes have been used to promote the water flux in the membrane and retain water and thus to reduce the ohmic resistance in the PEMFC. To some extent, use of thin membranes can promote self-humidification by enhancing water transport from the cathode to the anode.

Watanabe et.al[2] demonstrated modified thin membranes operating below 100^0 C with non-humidified gases. The present study attempts to modify thin membranes with inorganic composite materials (e.g. SiO_2) to enable high temperature operation in addition to the under humidified operation in the PEMFCs.

Figs.1 and 2 compare the current-voltage behavior of the unmodified and the modified membranes at 130^0 and 140^0 C respectively with reactant gas streams at 30 psig and humidified at 130^0 C. The modified membranes clearly show an increased performance at the reduced relative humidity conditions thus proving the advantages of better water retention and self-humidification under these operating conditions.

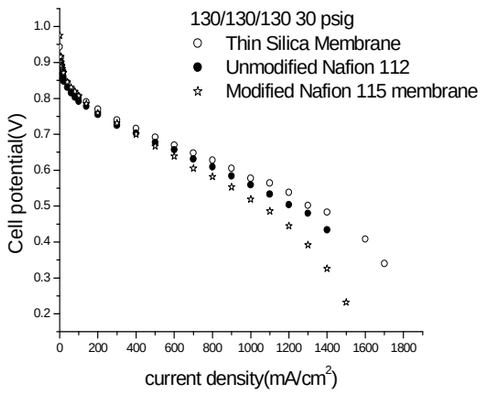

Fig.1

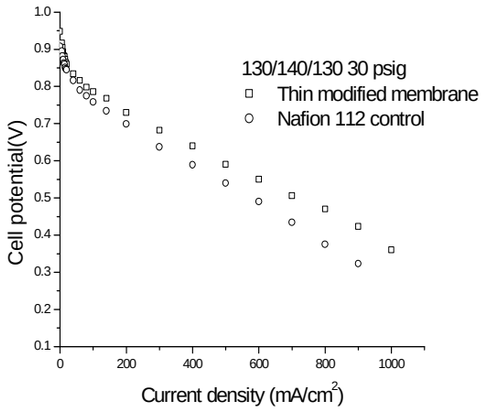

Fig.2

References:

1. K.T.Adjemian et.al, Journal of the Electrochemical Society, 149 (3) 2002.

2. Watanabe et.al, Journal of Physical Chemistry B, 102(17), 1998