ETHYLENE GLYCOL AND DIMETHYL OXALATE AS ALTERNATIVE FUEL TO METHANOL FOR DIRECT-OXIDATION FUEL CELLS.

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Direct-oxidation fuel cells (DOFC) employing organic fuels are extremely attractive as power sources for electric vehicles, and for both stationary and portable applications. Up to now, methanol has been found to be the best fuel for these cells. However methanol is toxic, highly flammable and has a tendency to pass through the fuel-cell membrane. As a result, in Nafion based DMFC, it has to be diluted to a concentration of 3-6% before being fed into the cell.

We recently reported the development of a new nanoporous proton-conducting membrane (NP-PCM) and have applied it in a direct methanol fuel cell (DMFC) (1,2). The use of the NP-PCM in the DMFC offers several advantages over the Nafion-based DMFC: Lower membrane cost (by more than two orders of magnitude), smaller pores (by a factor of two), lower methanol crossover (by up to one order of magnitude) leading to much higher fuel utilization, higher conductivity (by up to a factor of four). The ionic conductivity of the NP-PCM, unlike Nafion, is not affected by heavy-metal impurities. Thus it permits the use of cheaper catalysts and hardware materials.

Aliphatic alcohols are found to be very difficult to electrooxidize (3,4). Even at 190°C, in a polymer electrolyte FC, the oxidation of ethanol is incomplete. We report here, the complete electro-oxidation of two molecules having C-C bonds –ethylene glycol (EG) and dimethyl oxalate (DMO). Both are less prone to pass through the membrane and as a result have up to 94-95% fuel utilization, 9-10% higher than that of methanol. Ethylene glycol is well known in the automobile industry and, in contrast to methanol, its distribution infrastructure already exists, thus it is a promising candidate for practical electric vehicles. Dimethyl oxalate is a solid that has limited solubility in water thus it may be added directly to the anode compartment with no need of a separate fuel tank and monitoring and feeding systems.

The properties of these fuels and their application in the NP-PCM-based DOFC will be reported. The effects of temperature, oxygen pressure and fuel concentration on DOFC performance and on fuel crossover will be reported

References

1. E. Peled, T. Duvdevani, A. Melman; Eletrochem. and Solid State Letters; **1** (5) 210 (1998).
2. E. Peled, T. Duvdevani, A. Aharon and A. Melman, *ibid.* submitted.
3. P. Gao, S. Chang, Z. Zhou, and M. J. Weaver, J. Electroanal. Chem. 272,161 (1989).
4. J. Wang, S. Wasmus, and R. F. Savinell , J. Electrochem. Soc. 142, 4218 (1995)