119b Addressing Cathode Limitations in Laminar Flow Based Micro Fuel Cells

Ranga S. Jayashree, Eric R. Choban, Seong Kee Yoon, Alex Primak, Dilip Natarajan, Larry J. Markoski, and Paul J. A. Kenis

Recently we reported on a membraneless fuel cell that utilizes a characteristic of fluid flow at the microscale, laminar flow, to keep two streams containing fuel and oxidant, respectively, separated while still in diffusional contact [1]. The physicochemical phenomena of boundary layer depletion at the electrodes and diffusion across the mutual liquid-liquid interface govern the performance of these laminar flow-based fuel cells. The membraneless fuel cell system eliminates several of the technical issues related to the use of polymer electrolyte membranes including the occurrence of fuel crossover and membrane dry out. In addition, lack of a membrane enables operation in not only acidic media but also alkaline media, which has advantages with respect to both the cathode and anode performance [2].

To date, mass transfer limitations at the cathode caused by the low solubility of oxygen in aqueous media have limited the performance in these laminar flow-based micro fuel cells [1,3]. In this presentation different ways to address these cathode limitations will be discussed: (i) The integration of multiple inlets or outlets to, respectively, replenish or remove the depleted boundary layer on the cathode; (ii) the use of an oxidant that is highly soluble in aqueous media; and (iii) adjustment of the design to create an air-breathing laminar flow fuel cell.

[1] Micro-Fluidic Fuel Cell Based on Laminar Flow, E.R. Choban, L.J. Markoski, A. Wieckowski, P.J.A. Kenis, J. Power Sources, 2004,128, 54-60; US Patent 6,713,206 (2004). [2] Membraneless laminar flow-based microfuel cells operating in alkaline, acidic, and acidic/alkaline media, E.R. Choban, J.S. Spendelow, L. Gancs, A. Wieckowski, P.J.A. Kenis, Electrochimica Acta, 2005, in press. [3] Characterization of limiting factors of a laminar flow-based membraneless micro fuel cell, E.R. Choban, P. Waszczuk, P.J.A. Kenis, Electrochemical and Solid State Letters, 2005, 8(7), A348-A352.