PLANAR INTERCONNECTION OF MULTIPLE POLYMER ELECTROLYTE MEMBRANE FUEL CELLS BY MICROFABRICATION

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Fuel cells have become a prominent alternative to batteries for answering the need for miniature power sources, especially in response to the rapid growth of portable electronics. Fuel cells with polymer electrolyte membrane are particularly attractive because of low-temperature operation and relatively simple construction. However, practical implementation of miniature fuel cells requires interconnection of multiple cells to meet application-specific voltage requirements.

In the effort to miniaturize fuel cells, planar layout instead of vertical stacking provides a method to reduce overall cell volume through reduction of stack thickness.[1,2] Furthermore, for integrated layer manufacturing, complexity within a layer is generally preferred to complexity between layers.

A planar "flip-flop" interconnection layout previously proposed[1] that allows for a continuous polymer electrolyte membrane design is shown in Figure 1. This configuration has the advantage of simplified membrane processing. In addition, current collection is simplified because interconnection from the cathode of one cell to the anode of the next cell is done entirely within one plane. The design is well suited for thin-film or thick-film processing because it does not require a breach of electrolyte to make electrical connections, [1] nor do the electrodes have to connected by tabs at the outer boundary of the membrane.

This paper will present the implementation of this "flip-flop" configuration using micro-fabrication techniques. An example core component is shown in Figure 2. Figure 3 shows performance results demonstrated by a four-cell prototype. Functional concerns such as non-uniformity among cells and possible "cross-talk" between non-paired electrodes will also be discussed.

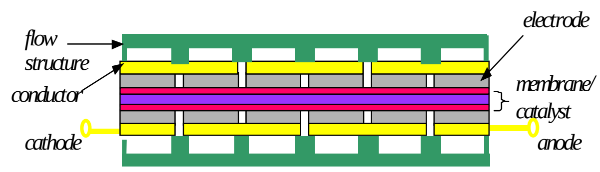

Figure 1. Multi-Cell Interconnection with Flip-Flop Configuration.

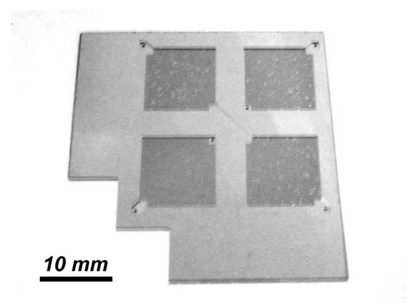

Figure 2. Miniature fuel cell flow structure in silicon, fabricated using three-level deep reactive ion etching (DRIE).

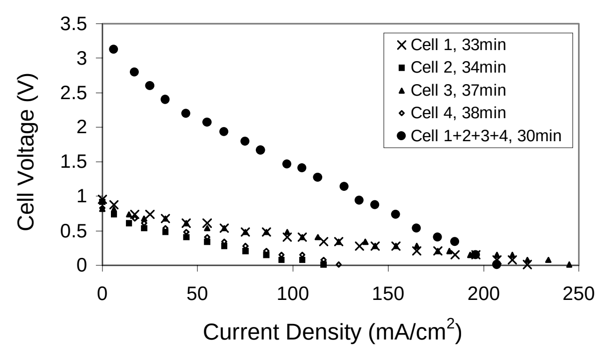

Figure 3. Overall and individual performance of four 1-cm^2 cells in "flip-flop" configuration using micro-machined flow structures. The active components consisted of conventional Nafion and carbon cloth with 0.4 mg/cm^2 platinum loading. Reactants were dry hydrogen and oxygen gases at 100 kPa, and no external heating was applied.

1. S.J. Lee, et al., in *Micro Power Sources*, PV 200-3, The Electrochemcial Society Proceeding Series, Pennington, NJ (2000).
2. Heinzel, R. Nolte, et al., *Electrochimica Acta*, (1998)