Lifetime and Power From a Direct Glucose Micro Fuel Cell

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The development of high energy density fuel cells for long duration sensor applications where access to the sensor system may be restricted requires that a premium be placed on the size of the converter and its lifetime, as well as the power output the system. To achieve a 1000 W-hr/l power output, for instance, requires that a 10mW continuous power supply be delivered in a 10ml total system volume for 6 weeks. For hard to reach sensor applications, access to the platform every 6 weeks to switch out power systems becomes untenable, and therefore other means must be developed. Lifetime scales with the size of the fuel tank, and therefore the size of the system, however, unless some means can be devised to harvest the fuel for the cell directly from the environment. Under these situations, long lifetime and small converter volumes can combine to provide unprecedented power densities.

A miniaturized fuel cell platform has been developed that operates on glucose and air. This cell performance is dramatically limited by the byproduct gluconolactone poisoning of the anode. Periodic pulsing of the anode up to oxidizing potentials results in the removal of poisons from the anode, allowing for continuous power to be delivered for long times from a noble metal catalyst. Data on several different anode catalyst metal combinations will be discussed, and optimal anode structure for utilizing environmentally harvested fuels will be shown. Under situations where the cathode is much more active than the anode, the cathode potential can be considered to be pinned at it's open circuit potential, and the anode potential will become more oxidizing and current is drawn from the cell. Under these conditions, a short circuit of the cell forces the anode up to the cathode potential, and allows for the oxidation of anode poisons with no net energy being input into the system to clean the anode. Since fuel is supplied from the environment freely, this "waste" of fuel can be tolerated to allow for the anode to be cleaned and operational lifetime to be extended. We will present data on the lifetime of operation of a cell being operated between a loaded and a short circuit condition under a series of oxygen supply conditions.

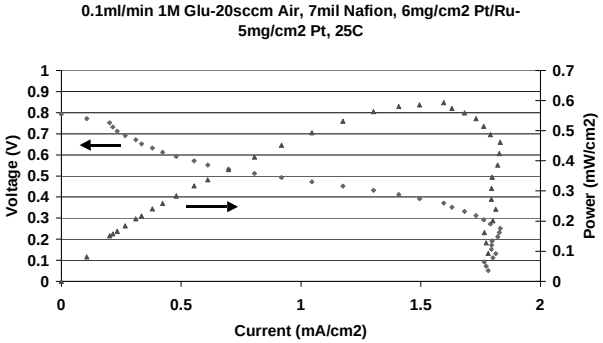

Figure 1: Cell performance at room temperature and passive air with 1M Glucose

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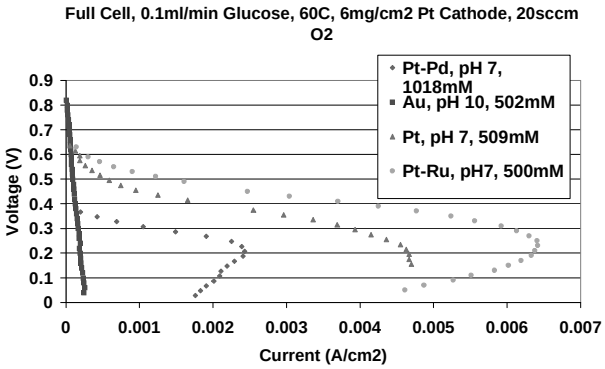

Figure 2: Cell performance with various noble metal alloy anodes

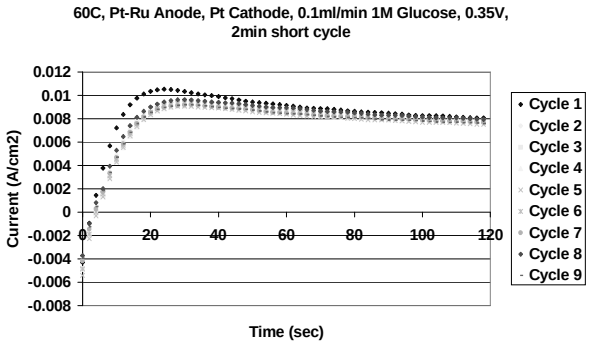

Figure 1: Cycling between short and load for 10 cycles, showing no degradation in cell performance