

CO Tolerant PEM Fuel Cells Through Magnetic Modification

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Proton exchange membrane (PEM) fuel cells are light-weight cells that provide power at low temperatures. Extant technology is effective for cells run on H_2 and O_2 or air, but safety issues associated with the fuel limit the applicability and commercialization of these cells. Cells operating by direct reformation of an organic fuel would find wider use; however, catalysts are rapidly passivated by the organic fuels and their decomposition products including CO. An intermediate solution, currently under extensive investigation, is indirect reformation. Indirect reformation systems operate by converting organic fuel and water into H_2 and CO_2 over a hot catalyst and feeding the reformat into the anode. Whereas catalysts such as Pt-Ru alloys, better tolerate reformat, they are still largely passivated by trace CO in the reformat.

Here, we report on magnetic modification of fuel cells to improve carbon monoxide tolerance. Magnetic micro-particles are incorporated into the catalyst layers of the fuel cells [1-8] with negligible weight increase.

In Figure 1, data are shown for two cells. One cell uses Pt-Ru catalyst in the anode; the second uses Pt catalyst with magnetic microparticles. Both cells were similarly formed using a Nafion separator. Cells were initially run on H_2 . At ~15 minutes into the experiment, the cells were switched to a simple reformat analog of $H_2 + 100$ ppm CO. For the nonmagnetic cell, the performance of the cell dropped dramatically, whereas the magnetic cell suffered only small demunition in performance.

In Figure 2, current voltage and power curves are shown. The Pt-Ru catalyst without magnetic modification performs poorly under the operating conditions of 70 C and 1 atmosphere pressure. For the magnetically modified cell, performance is similar on $H_2 + 100$ ppm CO and H_2 . There is no dimunition between 0.6 and 0.8 V.

Voltammetry of these systems and the importance of the magnetic microenvironment will be discussed.

References:

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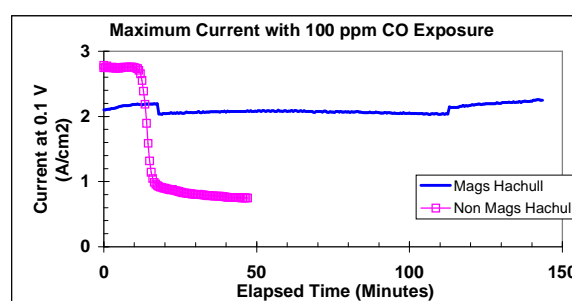


Figure 1: Response of Pt magnetic (-) and Pt-Ru nonmagnetic () anodes upon switching fuel from H_2 to $H_2 + 100$ ppm CO. The magnetic cell was switched back to H_2 at approximately 110 minutes.

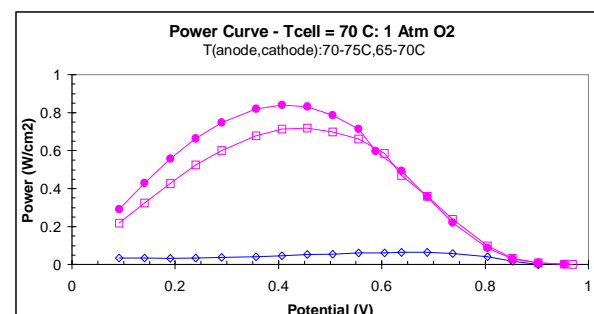
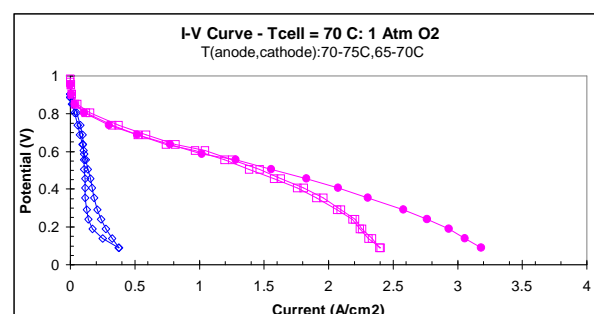


Figure 2: Data are shown for nonmagnetic (diamonds) and magnetic (circles and squares) anodes for H_2 (solid marker) and $H_2 + 100$ ppm CO (open markers). Flow rates are 400 cc/min and 600 cc/min for fuel and oxidant, except for the magnetically modified cell on $H_2 + 100$ ppm CO () where the anode flow rate is 150 cc/min. The catalysts are 0.4 mg/cm^2 in all cases, with Pt used except in the nonmagnetic anode on CO (\diamond) where Pt-Ru is used. Both cells have iron oxide magnets on the cathodes.