Title: PEMFC RECONFIGURED ANODES FOR ENHANCING CO TOLERANCE WITH AIR BLEED

Author(s): FRANCISCO A. URIBE
             THOMAS A. ZAWODZINSKI

Submitted to: THE MEETING OF THE ELECTROCHEMICAL SOCIETY IN PHILADELPHIA MAY 2002
PEMFC RECONFIGURED ANODES FOR
ENHANCING CO TOLERANCE WITH AIR
BLEED

Francisco A. Uribe and
Thomas A. Zawodzinski, Jr.
Los Alamos National Laboratory
MST-11, MS D429
Los Alamos, NM 87545

Practical PEM fuel cells based on
perfluorinated ionomer membranes (e.g., Nafion), most
probably will use reformed fuel as primary source for
the anode feed. The reformate, besides hydrogen, may
contain trace amounts of carbon monoxide (CO, from a
few to hundreds ppm), whose presence is detrimental
to the cell performance. Energy conversion at fuel cells
depends on highly dispersed carbon-supported Pt,
where the hydrogen electro-oxidation takes place.
However, CO strongly adsorbs on the Pt surface
leading to a decreasing of the Pt active surface area and
consequently to losses in electrical current that are
unacceptable for a practical device.

A technical approach for achieving CO
tolerance is to bleed a small amount of air into the
anode along with the fuel stream [1]. Oxygen from the
air is able to oxidize the CO adsorbed on the catalyst
layer to CO₂. The air cleans enough Pt sites, making
them available for H₂ electro-oxidation at an acceptable
rate.

We present here a variation on this approach,
that makes the presence of the air (oxygen) considerable more efficient in keeping the anode
catalyst activity. In a conventional PEM fuel cell, all
the anode catalyst content is placed directly onto the
ionomer membrane. The modification consists of adding a thin chemical catalyst layer onto the anode
gas distribution carbon cloth. In this way the CO
contaminated H₂, which also contains a small amount
of O₂ (from air bleed), will first encounter an outer
catalyst layer. This layer will promote the direct
chemical oxidation of the CO with O₂, before the fuel
stream reaches the internal catalyst layer where the
electrochemical oxidation of H₂ takes place.

Fig. 1 shows performances of a FC with a
"standard" anode configuration FC. Operation with 100
ppm CO impurity is considerably improved with 2 %
air bleed, but the tolerance is only partial. Figure 2
shows the performance of a reconfigured anode (RCA)
with equivalent total Pt loading. Part of the Pt in this
cell is in the MEA and the rest on the backing. Clearly
with this anode configuration, the same amount of air
bleed is able achieve full tolerance to 100 ppm CO.

Next, we present results with a reconfigured
anode whose chemical catalyst layer contains no
precious metals. Figure 3 shows performances of a FC
with a RCA containing Fe₂O₃ on the backing carbon
cloth and a typical anode Pt loading of 0.2 mg Pt cm².
In this case we achieved almost full tolerance to 100
ppm CO with 4% air bleed.

Other compounds, mostly non-precious
transition metal oxides, can also be used as catalysts
for the chemical oxidation of CO. The advantages of
this method are apparent. First, no major part is added
to the system, just a thin composite layer. Second, it
works at 80 °C, the operating cell temperature. And
third, the cost of these materials is orders of magnitude
lower than Pt.

References

Acknowledgment
We gratefully acknowledge funding from the US
DOE Office of Advanced Automotive Technology.

Figure 1. Polarization curves of a cell with a standard
anode, fed with various fuel compositions at 80 °C
Loadings/cm²: Anode membrane 0.46 mg Pt. Anode
backing: no catalyst. Cathode 0.20 mg Pt. Cell size: 5
cm².

Figure 2. Polarization curves of a fuel cell with a
reconfigured anode, fed with various fuel
compositions at 80 °C. Loadings/cm²: Anode membrane: 0.18 mg Pt. Anode backing: 0.29 mg Pt.
Cathode: 0.20 mg Pt. Cell size: 5 cm².

Figure 3. Polarization curves of a fuel cell with a
reconfigured anode at 80 °C. Loadings/cm²: Anode
membrane: 0.20 mg Pt. Anode backing 0.32 mg Fe₂O₃.
Cathode: 0.21 mg Pt. Cell size: 5 cm².