

LA-UR- 01-6954

Approved for public release;
distribution is unlimited.

21

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



Los Alamos

NATIONAL LABORATORY

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the U.S. Department of Energy under contract W-7405-ENG-36. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

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 reformat, 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 cm⁻². 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

1. S. Gottesfeld and J. Pafford, *J. Electrochem. Soc.* 135, 2651 (1988)

Acknowledgment

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

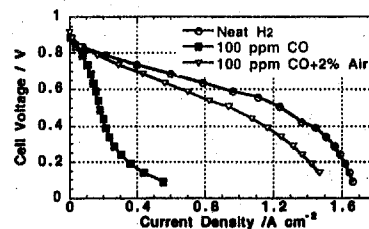


Figure 1. Polarization curves of a cell with a standard anode, fed with various fuel compositions at 80 °C. Loadings/cm²: Anode membrane 0.46 mg Pt. Anode backing: no catalyst. Cathode 0.20 mg Pt. Cell size: 5 cm².

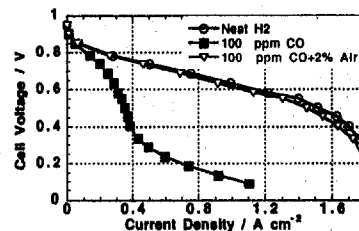


Figure 2. Polarization curves of a fuel cell with a reconfigured anode, fed with various fuel compositions at 80 °C. Loadings/cm²: Anode membrane: 0.18 mg Pt. Anode backing: 0.29 mg Pt. Cathode: 0.20 mg Pt. Cell size: 5 cm².

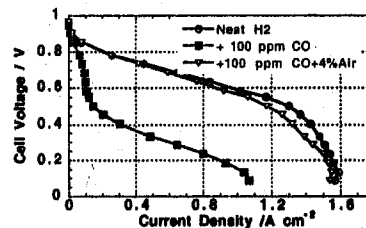


Figure 3. Polarization curves of a fuel cell with a reconfigured anode at 80 °C. Loadings/cm²: Anode membrane: 0.20 mg Pt. Anode backing 0.32 mg Fe₂O₃. Cathode: 0.21 mg Pt. Cell size: 5 cm².