Instabilities of the reversible hydrogen reference electrode in direct methanol fuel cells

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Introduction

For the application of the direct methanol fuel cell (DMFC) as an power supply it is important to increase its power output. This output depends on the efficiency of the single electrodes and therefore, elektrode specific measurements are most important. Reference electrodes have to be used to discriminate the voltage signal of the anode and cathode.
Different groups have shown that a dynamic hydrogen electrode (DHE) or a reversible hydrogen electrode (RHE) in a DMFC can be used as a reference. However, it was also reported that misalignment of the anode and cathode or membrane potentials can disturb the reference measurements.

We are interested in processes under the conditions of low cathodic volume flow with dry air. This is important because devices for high volume flows in a DMFC system finally result in an reduced power output.

Therefore, we investigated the influence of the cathodic air flow on the reference measurements with an RHE in a liquid fed DMFC. We found that the reference measurements with an RHE can be disturbed by low volume flows.

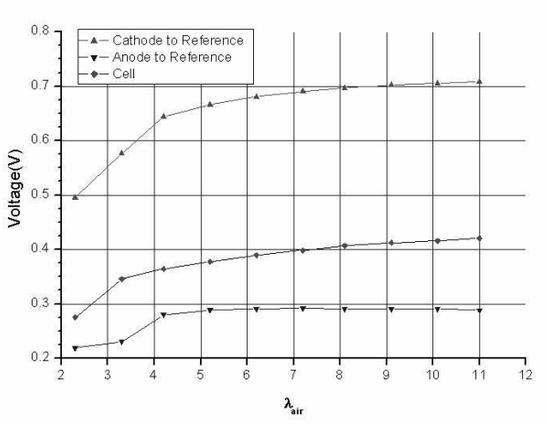
Experimental

The experiments were carried out with catalyst-coated membranes and a platinum grid as a current collector. No diffusion layers were used.
Nafion® 117 membranes were coated with a suspension of 60% Pt/Ru /C + Nafion® (anode) and 60% Pt/C + Nafion® (cathode) and were pressed at 130°C for 3 minutes with a pressure of 0.5 kN/cm^2 . Next to the active area a Pt reference electrode was pressed onto the membrane. The cell area was 18.5 cm^2 and the cell temperature 80°C. The cathode was fed with dry air and the reference electrode with hydrogen. The constant flow of aqueous 1 M methanol solution was 3.8 ml/min.

We tested the stability of the reference potential as a function of the stoichiometric volume flow λ_{air} at the cathode and the current density j.

Results and Discussion

The stability of the reference potential in liquid fed DMFC with an RHE depends on the cathodic stoichiometric volume flow. It is possible to attain stable single potentials for at least four weeks yet for some air stoichiometric levels it is difficult to stabilize the reference potential for an hour.
By varying the current density j and λ_{air} we found the stability of the reference potential to be dependent on these parameters. The figure shows the anode, cathode and cell voltage of the DMFC for a constant current density of j = 0.14 A/cm^2 as a function of λ_{air}. The shift in the anode potential between λ_{air} = 3 and λ_{air} = 4 is not visible in the cell voltage. Thus, a shift in the reference potential is proven to be induced by low cathodic stoichiometric volume flow.



Effect of the reduced λ_{air} on the voltages.
j = 0.14 A/cm^2, T_{Cell} = 80°C, V'_{MeOH} = 3.8 ml/min , c (MeOH)= 1 M, cathode: Pt/C, 2 mg/cm^2 ; anode: Pt/Ru/C 2 mg/cm^2.

References

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