RECENT PROGRESS IN METHANOL CROSSOVER REDUCTION USING PALLADIUM COATED NAFION

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Introduction

Methanol crossover occurs in direct methanol fuel cells (DMFC) as a parasitic phenomenon due to the solubility of methanol in aqueous media and incomplete consumption at the DMFC anode. The fraction of methanol that is not oxidised at the anode is transported through the electrolyte and reacts with oxygen at the cathode in a currentless reaction, which compromises the cell performance. Several strategies have been followed to find materials that reduce methanol crossover [1]. The introduction of metallic palladium as a barrier layer was initially tried by C. Pu et al. [2]. Recently it has been demonstrated that thin layers of metallic palladium deposited by means of electroless plating reduces methanol crossover and enhances cell performance [2]. Measurements were performed with commercial fuel cell electrodes, which did not show full compatibility with our test cell shown in Fig. 1. In this work we present experimental results obtained with home made gas diffusion electrodes.

Experimental

Pd/Nafion composites were prepared by electroless plating using a well described process [3] based on commercial solutions (Neoganth®, Pallatect PC®). The quality of the deposition was monitored by environmental scanning electron microscopy (ESEM).
For the conduction of the electrochemical experiments in a test cell (Fig. 1) both commercial (ESNS type and ELAT type, manufactured by ETEK – De Nora) and self developed DMFC gas diffusion electrodes were used.
The self developed electrodes consisted of gold plated Ni-mesh, a diffusion layer of carbon black and PTFE and a catalyst layer consisting of 20 wt.-% Pt:Ru (1:1 atomic ratio) resp. 30 wt.-% Pt on Vulcan-XC 72. The preparation scheme is shown in Fig. 2.

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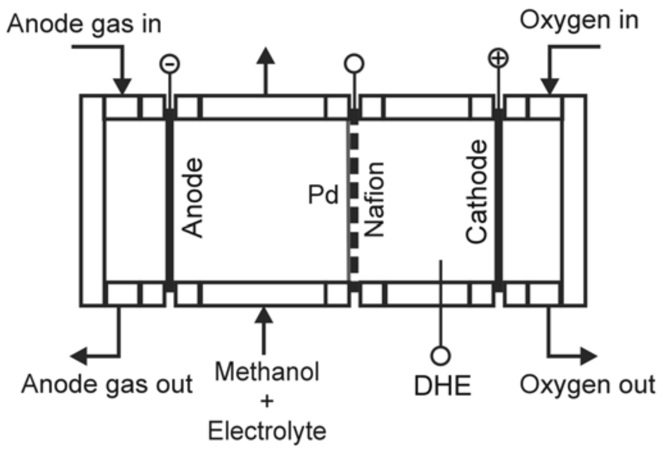

Fig. 1 *Side view of the test cell. A dynamic hydrogen electrode (DHE) was used as a reference electrode. Fuel was fed into the cell by pumping liquid acid electrolyte with a methanol concentration of 1 M through the compartment between anode and Pd membrane. Carbon dioxide was removed from the system by a flow of inert gas at the backside of the anode. An electric contact at the palladium layer allowed applying an electrochemical potential.*

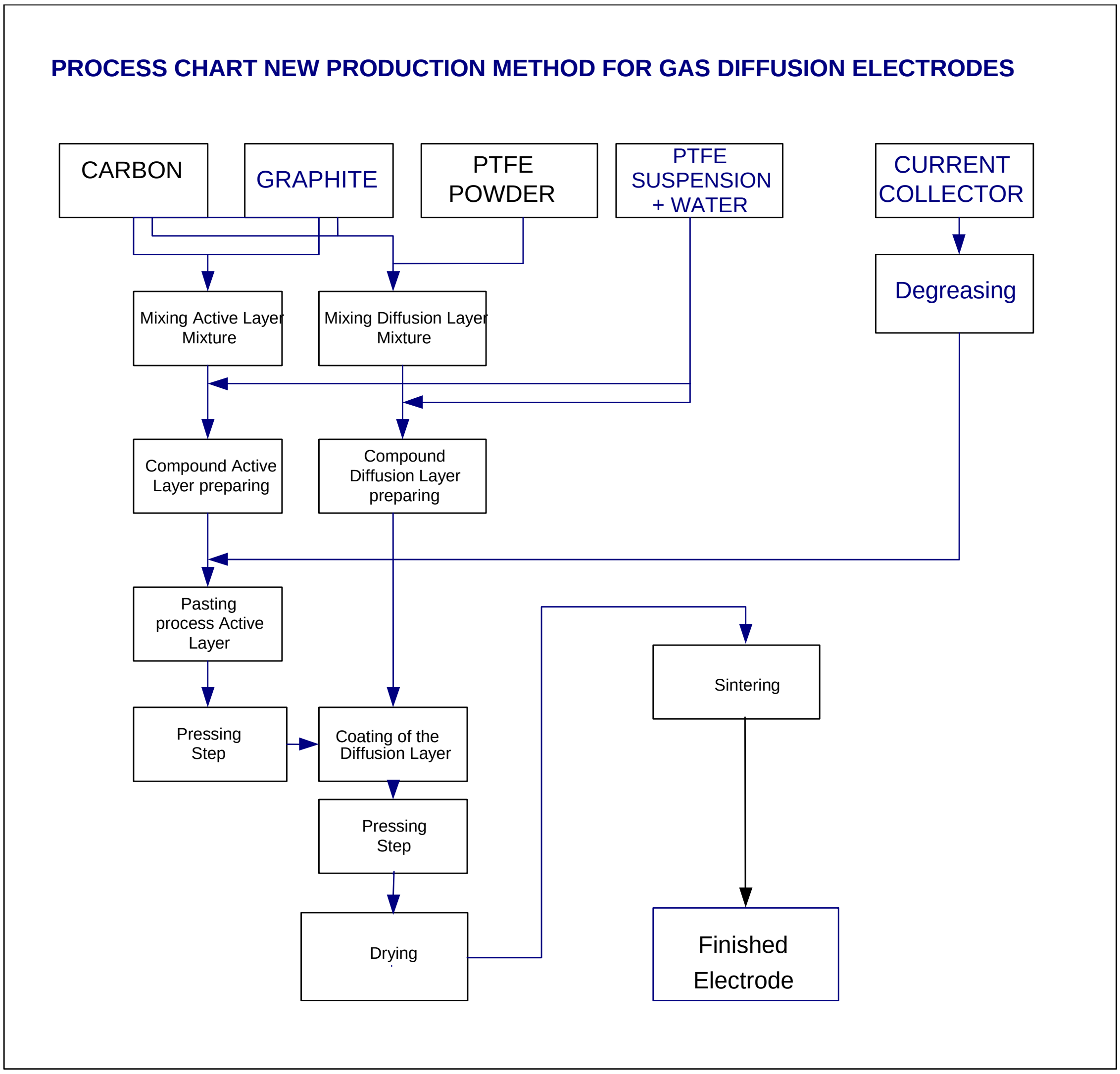

Fig. 2 *Preparation process of the self fabricated DMFC electrodes*

With all types of electrodes both current-voltage scans and constant current experiment were carried out. The methanol crossover was monitored by measuring the methanol concentration in the catholyte [3].

Results and Discussion

Fig. 3 shows the electrochemical performance of the test cell with self fabricated electrodes. The results were significantly better than those obtained with ELAT electrodes and slightly better than those obtained with ESNS electrodes. However, while the ESNS electrodes showed severe corrosion after the electrochemical experiments, the home made electrodes remained intact.

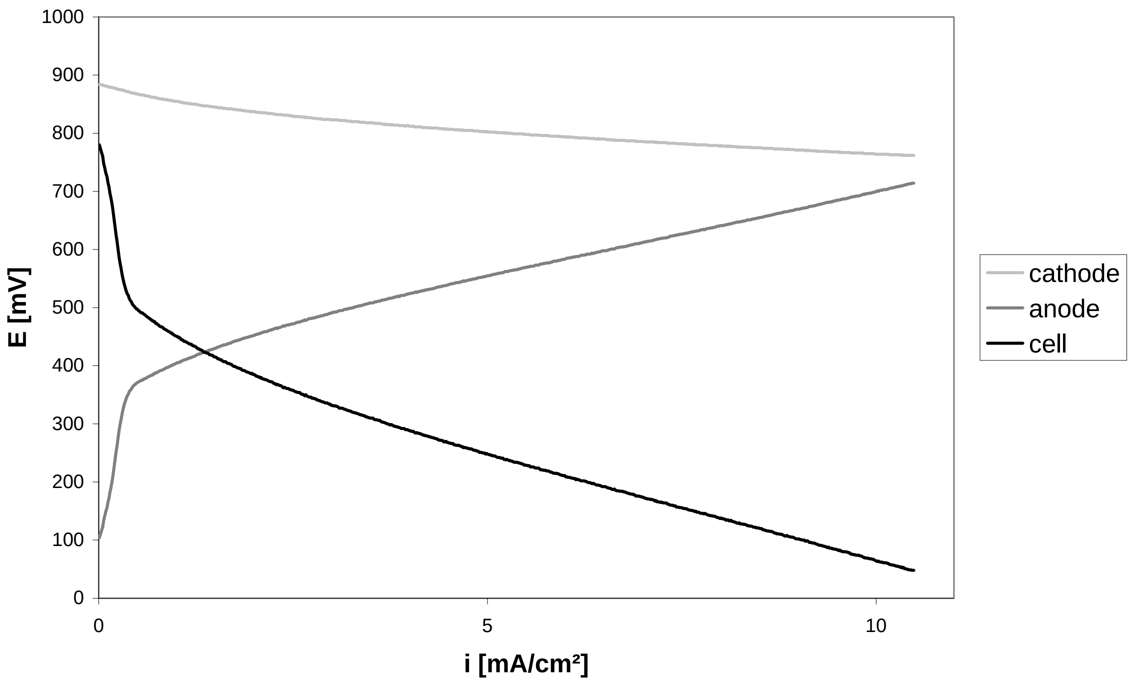

Fig. 3 *Current density-potential plot for methanol crossover experiments with self fabricated electrodes; T = 65°C, E(Pd) = 400 mV vs. DHE.*

Acknowledgements

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