MATERIALS CHARACTERISATION OF PD/NAFION® COMPOSITES OBTAINED BY ELECTROLESS PLATING

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Introduction

The use of layers of metallic palladium is a promising strategy to reduce methanol crossover in direct methanol fuel cells. Several different approaches have been tried to introduce such layers into a direct methanol fuel cell:
a) mounting a foil of palladium between two membranes of Nafion® [1]
b) sputtering layers of metallic palladium onto Nafion® membranes [2-4]
c) depositing metallic palladium onto Nafion® membranes by means of electroless plating [5, 6]

By method (a) a complete suppression of methanol crossover was achieved, but no increase of performance was observed due to the thickness of the foil. By method (b) only layers with cracks were produced. Method (c) allowed fabricating Pd/Nafion® composites which were able to decrease methanol crossover and increase electrochemical cell performance as well [7]. In this work we are presenting the results of material characterisation experiments.

Experimental

Nafion® (Sigma Aldrich) was pre-treated with acidic aqueous solution, and then submitted to an electroless plating process based on commercial baths (Neoganth®, Pallatect PC®). A special holder was used in order to obtain single-side plated composites. The resulting samples were studied by environmental scanning electron microscopy (ESEM) and atomic force microscopy (AFM). The swelling behaviour of the composites was studied by dipping experiments in aqueous solutions at different pH.

Results and Discussion

Characterisation of the membrane composites by scanning electron microscopy lead to experimental artefacts as shown in Fig. 1. The ultrahigh vacuum applied in this method resulted in complete drying out of the polymer electrolyte and lead to cracks in the palladium layer. When ESEM or AFM was used as characterisation method the water loss was slowed down. The membrane did not contract as much and the palladium layer did

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not break but was folded up (Fig. 2 and Fig. 3).

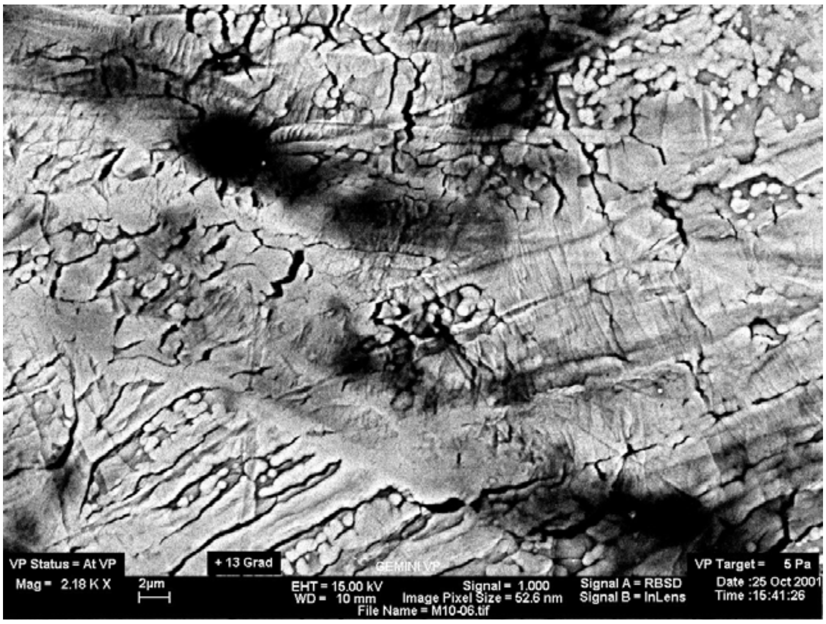

Fig. 1 *Scanning electron micrograph of Pd plated Nafion, the cracks occurred as a result of the applied ultra high vacuum.*

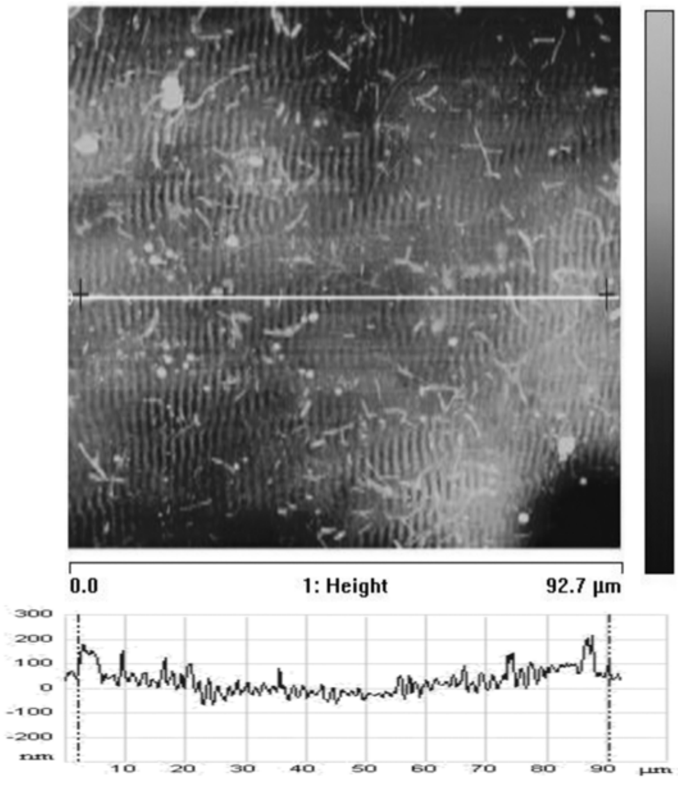

Fig. 2 *Atomic force micrograph of Pd plated Nafion, the experiments were conducted at ambient pressure and temperature. The relative humidity was 70%, therefore the samples showed the symptoms of a mild drying process visible as folds of the surface.*

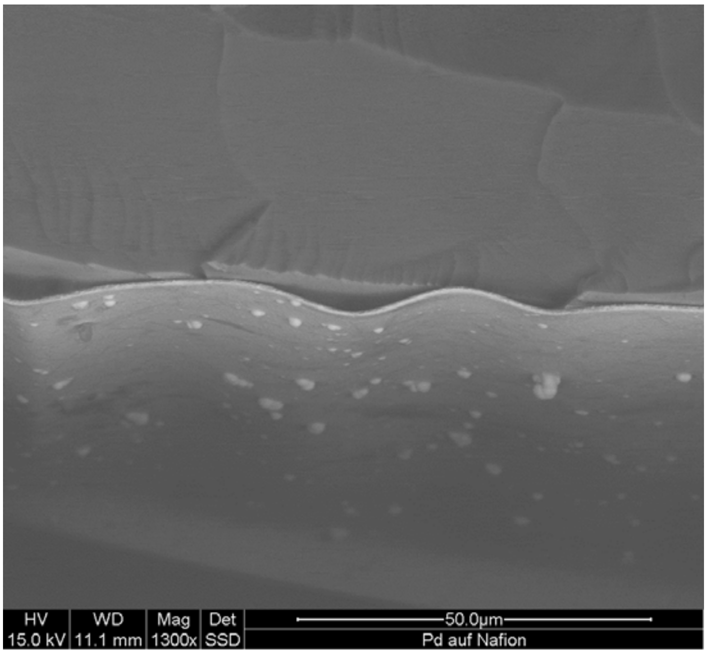

Fig. 3 *ESEM micrograph of Pd plated Nafion, the sample was prepared for a cross section: first a mild drying procedure was applied, then the sample was embedded in Epofix.*

Immersion experiments revealed a dependency of the geometrical expansion on the pH of the immersion solution.

Conclusions

Using ESEM and AFM it was possible to check the quality of palladium layers produced by electroless plating on Nafion. It was demonstrated that these layers contain no cracks and almost no pinholes.

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