High performance of catalysts supported by directly grown PTFE-free micro-porous CNT layer in proton exchange membrane fuel cell

He-Yun Du,[a] Chen-Hao Wang,[b]* Hsin-Cheng Hsu,[c] Sun-Tang Chang,[c] Shi-Chern Yen,[a] Li-Chyong Chen,[c] Balasubramanian Viswanathan,[d] and Kuei-Hsien Chen,[c,eb]

Received (in XXX, XXX) Xth XXXXXXXXX 200X, Accepted Xth XXXXXXXXX 200X
First published on the web Xth XXXXXXXXX 200X
DOI: 10.1039/b000000x

Supplementary Infornmation

Supporting experimental setup

Three-electrode fuel cell setup

In order to individually measure the cathode, we use three-electrode fuel cell (Asia Pacific Fuel Cell Technologies Ltd.), as shown in Fig. S1. A Pt disk was pressed on the membrane purged by H_2, acting as the dynamic hydrogen electrode (DHE) and the reference electrode (RE); the anode was the counter electrode (CE) and the cathode was the working electrode (WE). The measurments were performed with a Solartron 1255B frequency response analyzer in a frequency range of 2 KHz to 50 mHz (10 points/decade) and dc bias was applied by an Solartron 1287 potentiostat/ galvanostat. An ac sinusoidal perturbation of 10 mV in amplitude was superimposed on a dc bias.

Measurement of electrochemical surface area

To measure the electrochemical surface area (ECSA) of the cathode, the cyclic voltammetry (CV) curves of single cell condition were measured with N_2 instead of O_2/air at the cathode side.[1] The ECSA was calculated by hydrogen adsorption/desorption peak areas as the following equation:

$$\mathrm{ECSA\ (cm^2)} = \frac{Q_H}{210 \times 10^{-6}}$$

Supporting text and figures

The electrochemical impedance spectroscopy (EIS) is an effective technique to examine the mass transport of MEA, which is related to the water management of the gas diffusion electrode.[2, 3] Typical EIS spectra for Pt/MPL-CNT MEA were performed at the first polarization cycle and after 100 polarization cycles, showing the Nyquist plots in Figs. S2a and S2b, respectively, which indicates that the low-frequency relaxation process was mainly due to water flooding of the cathode. The plots are fitted by the model proposed by Malevich *et al.*[4] The mass-transfer resistances (R_{mt}) and the charge-transfer resistances (R_{ct}) at each potential are demonstrated in Fig. S2c. Malevich *et al.* proposed the R_{mt} corresponding to water/oxygen transport processes.[4] In this work, it clearly demonstrates that the R_{mt} at each potential is increased only slightly after 100 polarization cycles, indicating that Pt/MPL-CNT MEA maintains the wetting property after 100 polarization cycles.

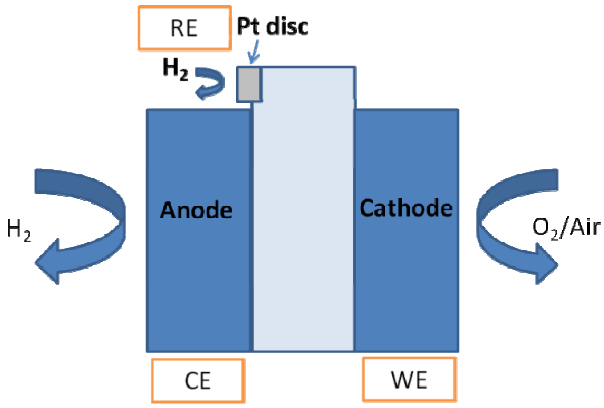

Fig. S1 The setup of three-electrode fuel cell.

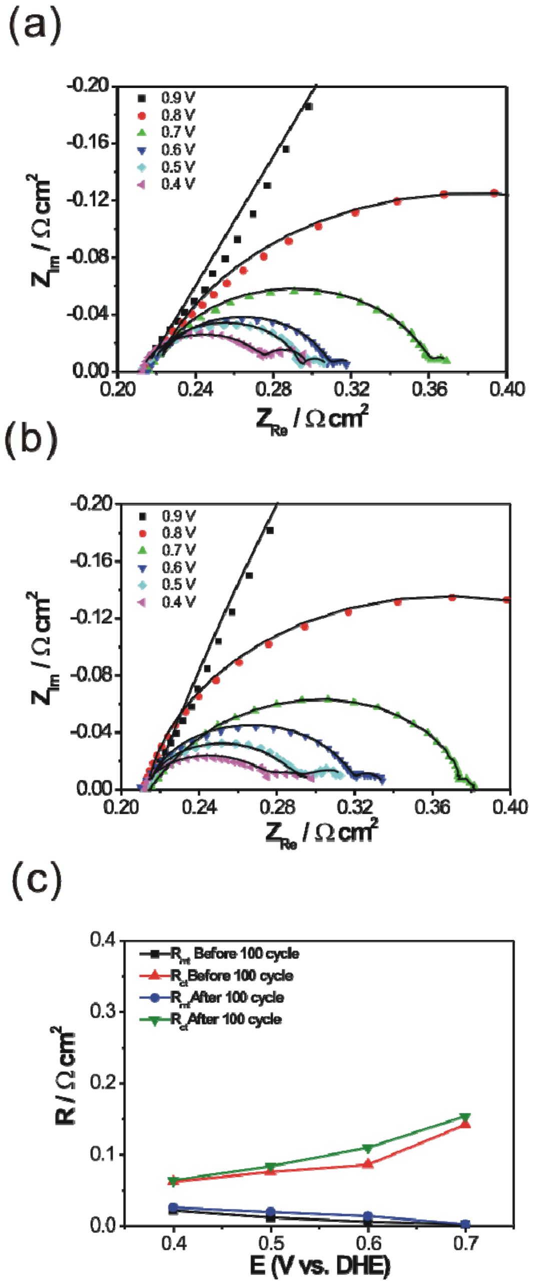

Fig. S2 The Nyquist plots for Pt/MPL-CNT MEA at (a) the first polarization curve and (b) after 100 polarization curves. (c) R_{mt} and R_{ct} at each potential.

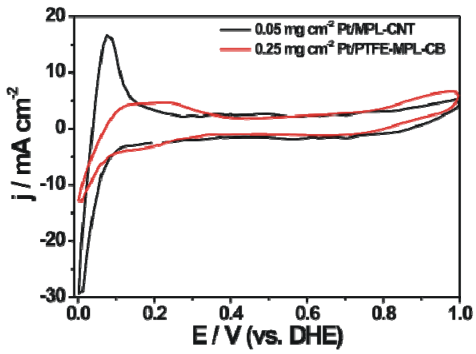

Fig. S3 The CV curves of Pt/MPL-CNT and Pt/PTFE-MPL-CB with scan rate of 50 mV s^{-1}. Anode: H_2 and cathode: N_2.

References

1. Z. Q. Tian, X. L. Wang, H. M. Zhang, B. L. Yi and S. P. Jiang, *Electrochem. Commun.*, 2006, **8**, 1158-1162.
2. T. J. P. Freire and E. R. Gonzalez, *J. Electroanal. Chem.*, 2001, **503**, 57-68.
3. S. L. A. da Silva and E. A. Ticianelli, *J. Electroanal. Chem.*, 1995, **391**, 101-109.
4. D. Malevich, E. Halliop, B. A. Peppley, J. G. Pharoah and K. Karan, *J. Electrochem. Soc.*, 2009, **156**, 216-224.