

Anode Catalysts Tailor Made for Direct Methanol Fuel Cells

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Anode catalysts (Pt-Ru/C) for Direct Methanol Fuel Cells (DMFCs) have been investigated regarding the optimal catalyst composition. It is found that the results depend strongly on the temperature of investigation. In order to test the catalysts in a half cell arrangement, gas diffusion electrodes were fabricated by spraying the catalyst mixed with 15 % w/o Nafion onto Toray carbon paper at 130 °C. These electrodes were then exposed to an electrolyte solution of in 1 M H₂SO₄ and 1.5 M MeOH. The half cell work presented ranges in temperature from 25 to 65 °C with full cell results conducted at higher temperatures.

All of the catalysts discussed here were prepared using a standardized sulphito method.[1] To ensure that the deposition process had the minimum possible effect on catalyst performance only one parameter was varied at any one time with all others remaining fixed. To investigate the effect of the Pt : Ru ratio only the amount of the Ru precursor added was varied. To investigate the effect of the metal to support ratio only the amount of carbon support being introduced in the final step of the deposition was varied.

Catalysts with two different Pt to Ru ratios were compared at several different temperatures. The two ratios investigated were 1 : 1 and 3 : 2 atomic. The results showed that at 25 °C the 3 : 2 atomic ratio catalyst offered the superior performance while at 65 °C the 1 : 1 atomic ratio catalyst was superior. If an intermediate temperature is looked at (e.g. 45 °C) then the performance of the two catalysts crossover with the 3 : 2 catalyst being the superior at low currents, see Fig. 1.

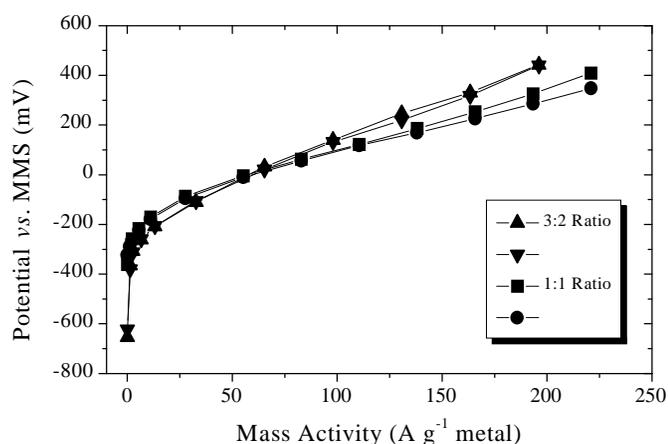


Fig. 1 Mass activity curves for 3 : 2 and 1 : 1 atomic ratio 30% w/o Pt-Ru/C catalysts at 45 °C in 1 M H₂SO₄ and 1.5 M MeOH.

These results clearly show that the optimal ratio of Pt : Ru for methanol oxidation changes with temperature. It will therefore be necessary to tailor this parameter to the cell operating conditions.

Figs. 2 & 3 show the effect on the Pt-Ru catalyst of varying the amount of carbon support present from 10 to 90 % w/o. at 25 and 65 °C respectively. The values of mass activity plotted are for a potential of 0 V vs. MMS.

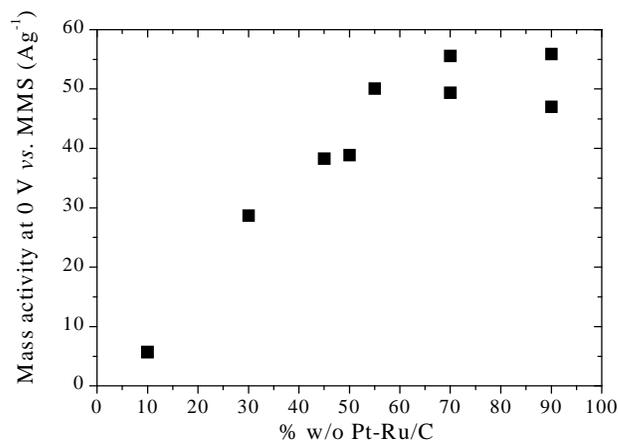


Fig. 2 Comparison of Pt-Ru/C samples, mass activity versus metal weight percentage at 25 °C.

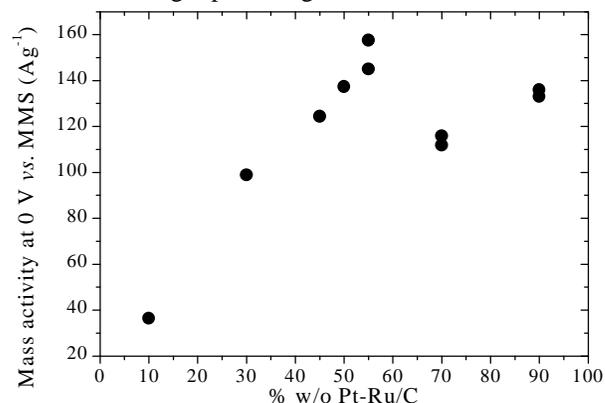


Fig. 3 Comparison of Pt-Ru/C samples, mass activity versus metal weight percentage at 65 °C.

As can be clearly seen from Fig. 2 the maximum performance at 25 °C is obtained from a catalyst with a metal loading of 90 % w/o. This would seem to indicate that at low temperatures operation with a very high Pt-Ru to C ratio would be beneficial.

Raising the half cell operating temperature to 65 °C, see Fig. 3, produces a plot with a maximum centered around about 55 % w/o. This would seem to indicate that operation of a DMFC at elevated temperatures would benefit from a lowering of the Pt-Ru to C ratio.

Full cell results are being conducted at a cell operating temperature of 110 °C in order to determine the optimum value of the Pt-Ru to C ratio at this temperature.

These results clearly show that the exact composition of the Pt-Ru/C catalyst has to be tailored to the cell operating conditions in order to obtain maximum performance.

[1] M.K. Ravikumar & A.K. Shukla, *J. Electrochem. Soc.*, 143 (1996), 2601.

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