

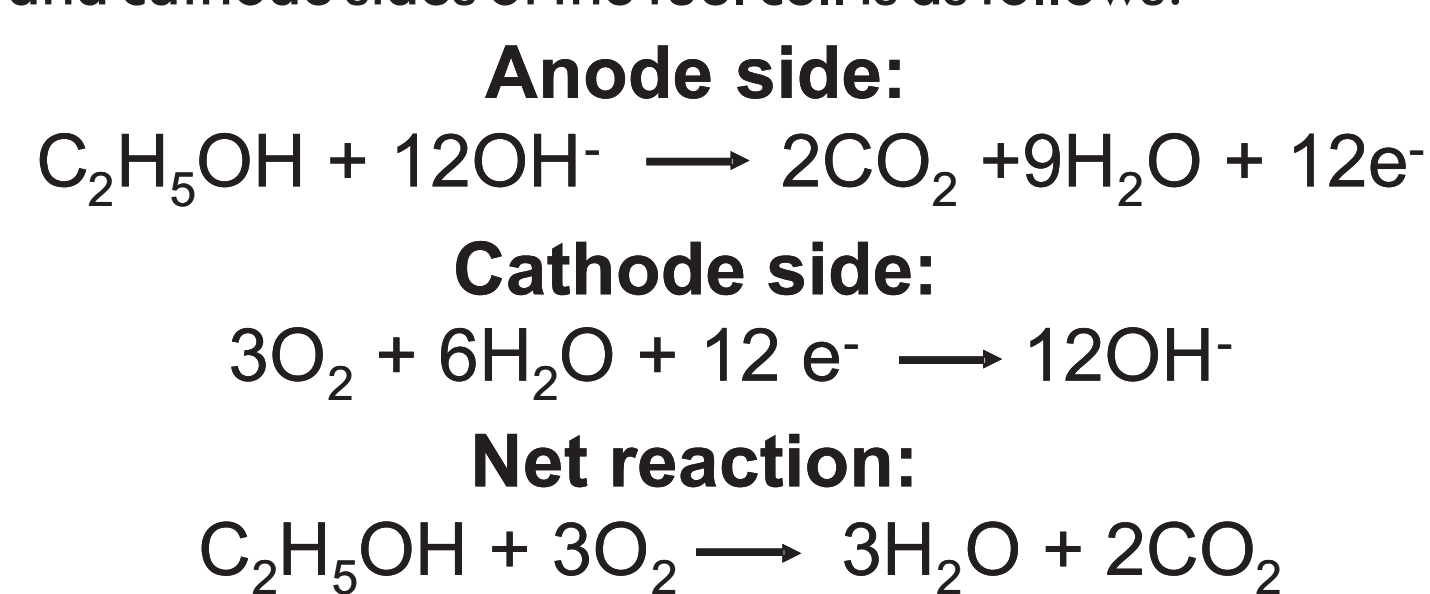
SYNTHESIS AND CHARACTERISATION OF BINARY ELECTROCATALYSTS FOR ELECTROCHEMICAL OXIDATION OF ETHANOL IN PEMFC

T. Masombuka, R.M. Modibedi, M.K. Mathe

Materials Science and Manufacturing, Energy and Processes, CSIR, Pretoria
tmasombuka@csir.co.za

INTRODUCTION

Fuel cells represent a technology whose competitiveness and feasibility is hinged on catalyst performance at low temperature with methanol or ethanol as the fuel. Direct Alcohol Fuel Cells are an environmentally friendly technology and are attracting considerable interest as a means of producing electricity. Ethanol oxidation is a very complex reaction involving 12 electrons. The oxidation reaction of ethanol on both anode and cathode sides of the fuel cell is as follows:



Ethanol electrooxidation catalysts that are more active than Pt need to be developed in order to improve the performance of the direct ethanol fuel cell. In this study binary Pt-Sn/C and Pt-Ir/C were synthesized and their electrochemical activities towards ethanol oxidation were compared.

EXPERIMENTAL WORK

In this study PtSn/C and PtIr/C electrocatalyst were synthesized by a chemical deposition method using formic acid as reducing agent.

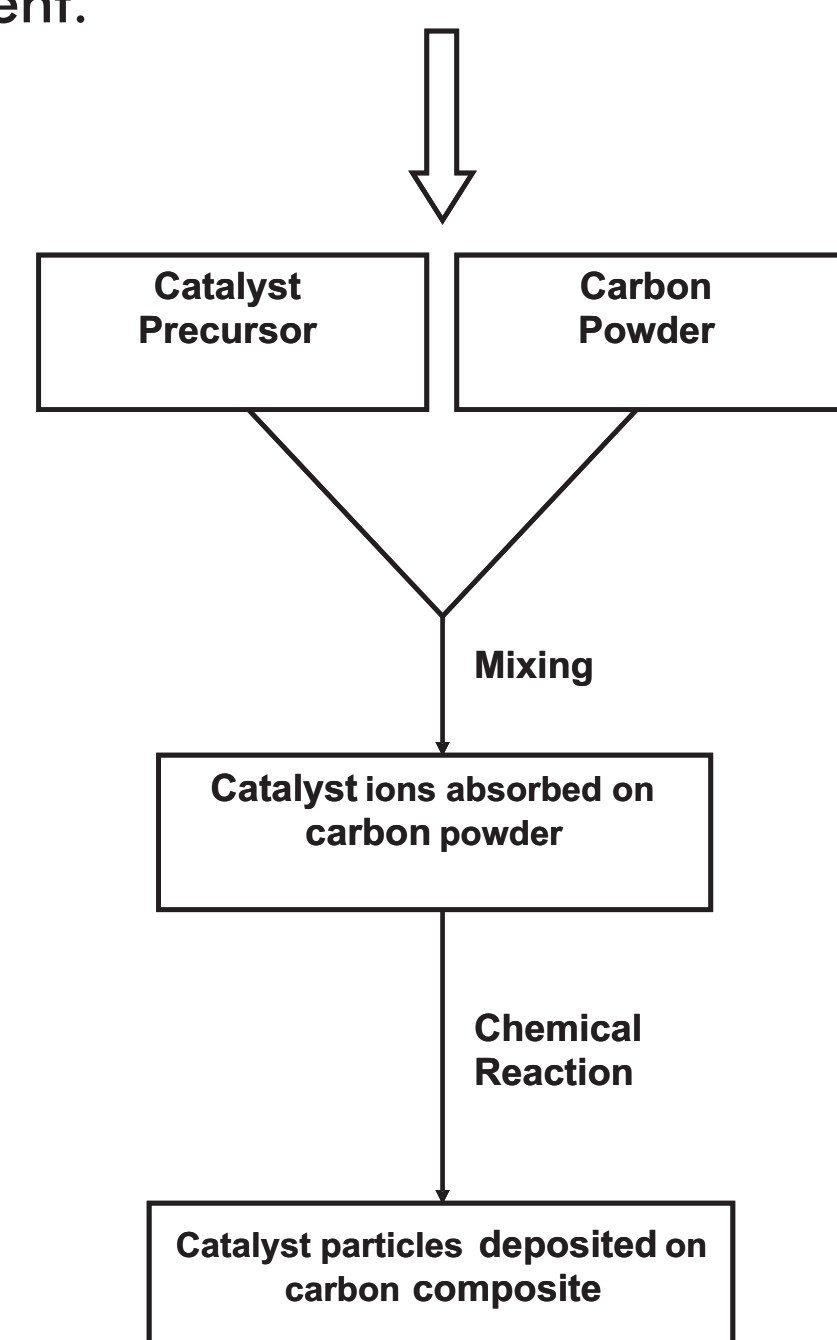


Figure 1: Schematic representation of the electro-catalysts deposition method.

RESULTS

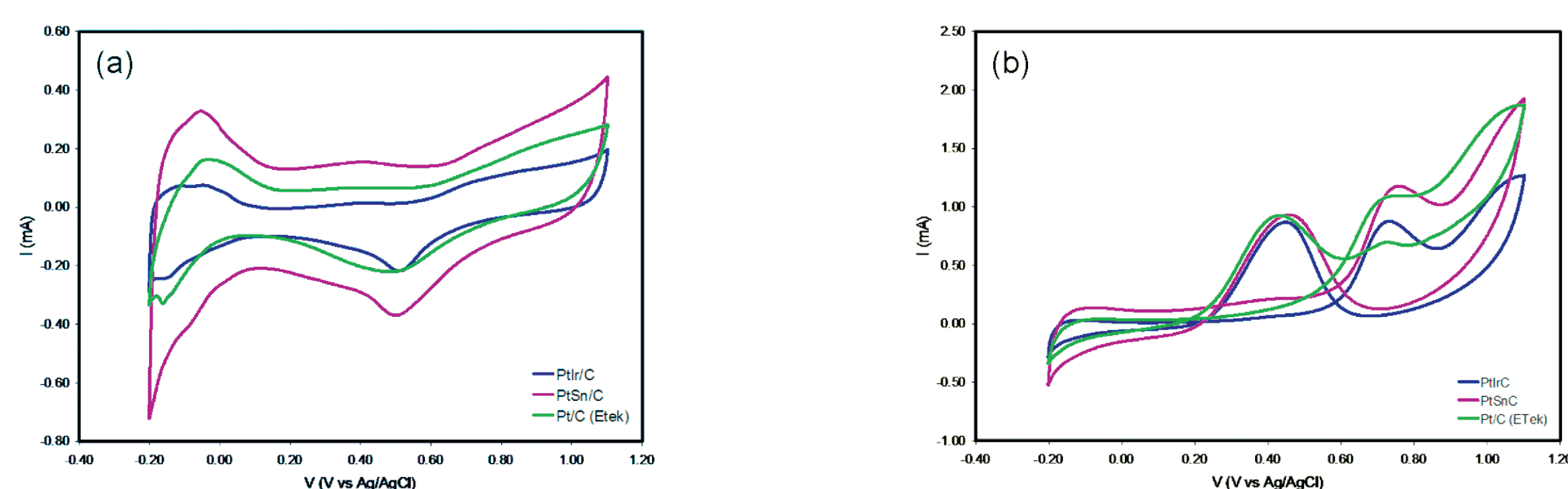


Figure 2: Cyclic voltammograms of electro-catalysts in (a) 0.5M H₂SO₄ and (b) 0.5M H₂SO₄ + 0.5M C₂H₅OH at 50mV/s and 25°C

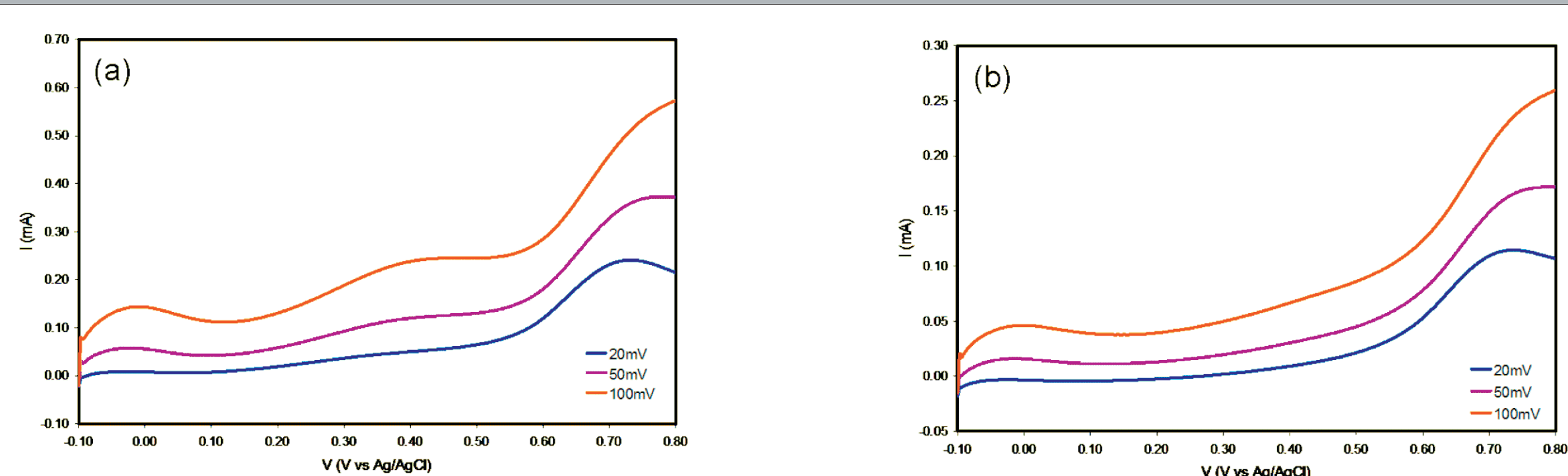


Figure 3: Linear sweep voltammograms for ethanol oxidation at various sweep rates for (a) PtSn/C and (b) PtIr/C in 0.5M H₂SO₄ + 0.5M C₂H₅OH at 25°C

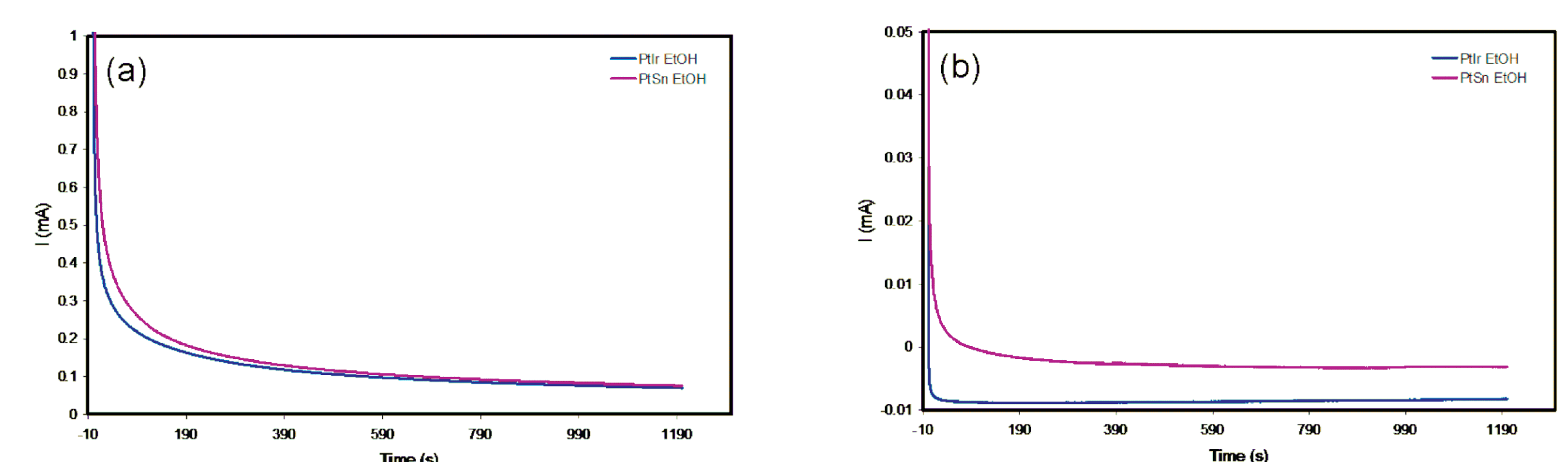


Figure 4: Chronoamperometry results in 0.5M H₂SO₄ + 0.5M C₂H₅OH at (a) 0.75V and (b) 0.2V for 1200s

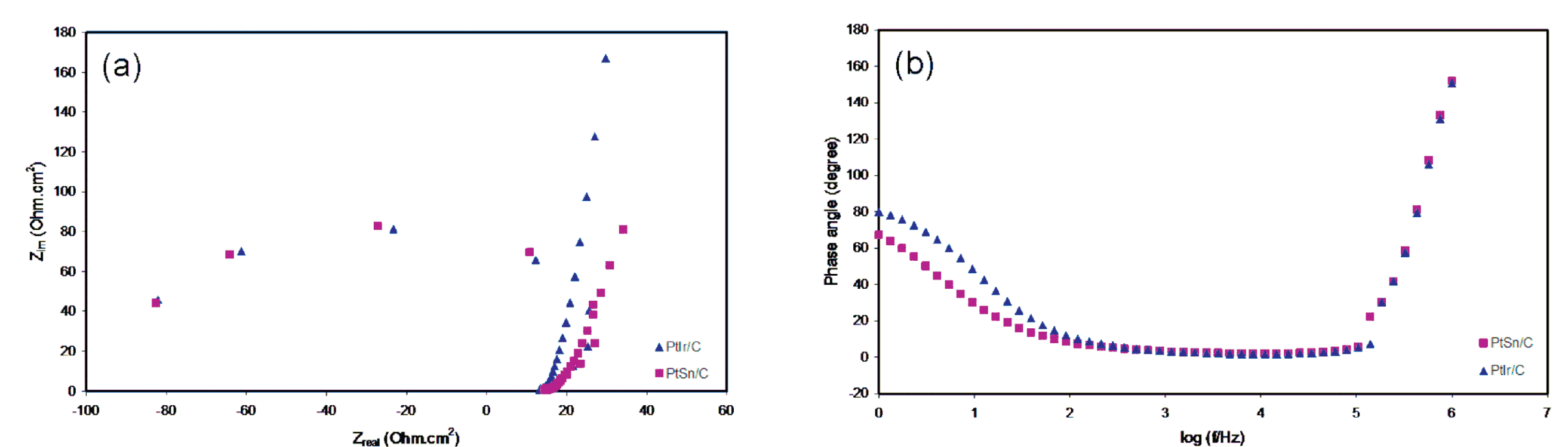


Figure 5: (a) Impedance patterns at 0.2V for ethanol electrooxidation (b) Phase shift plots of ethanol electrooxidation in 0.5M H₂SO₄ + 0.5M C₂H₅OH

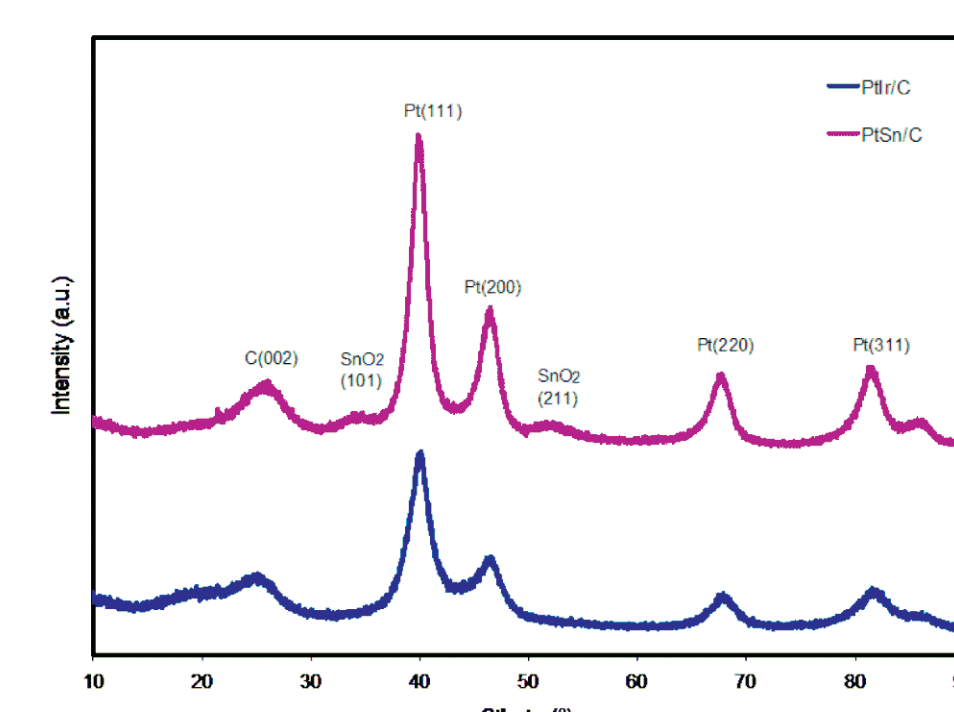


Figure 6: XRD spectra, Cu-K α source

Table 1: Crystallite sizes

Electro catalyst	D (nm) (111)	D (nm) (200)	D (nm) (220)	D (nm) (311)
Pt/C	4.6	6.2	5.0	3.9
PtSn/C	5.2	5.5	4.7	4.5
PtIr/C	3.8	5.1	3.7	3.7

CONCLUSIONS AND FUTURE WORK

- PtSn and PtIr were successfully deposited on carbon black by the chemical method resulting in a reduced crystallite size with reference to Pt(220) diffraction peak.
- Addition of Sn and Ir to Pt/C showed a performance improvement to ethanol oxidation.
- PtSn/C showed a superior electrocatalytic activity to ethanol oxidation in comparison to Pt/C and PtIr/C.
- Linear sweep voltammograms showed that the current increases with increasing potential scan rate
- The chronoamperometry curves showed different promotion effects of electro-catalysts at low and high potential regions of ethanol oxidation. PtIr/C promotion effect is comparable to that of PtSn/C at a high potential.
- The diameter of the arc obtained from impedance studies for PtSn/C and PtIr/C is the same, indicating that the charge transfer resistance for the ethanol oxidation is the same.
- TEM studies on the prepared electrocatalysts will be performed to determine the average particle size.
- Membrane Electrode Assemblies will be fabricated using prepared electro-catalysts and tested for performance in direct ethanol fuel cell.

REFERENCES

- E. Antolini, F. Colmati, E.R. Gonzales; Electrochemistry Communications. 9 (2007) 398-404
- Y. Guo, Y. Zheng, M. Huang; Electrochem Acta 53 (2008) 3102-3108
- A.O Neto, R.R.Dias, M.M Tusi, M. Linardi, E.V. Spinace; Journal of Power Sources 166 (2007) 87-91
- F. Colmati, E. Antolini, E.R. Gonzalez; Applied Catalysis 73 (2007) 106-115
- E.V. Spinace, A.O. Neto, T.R.R. Vasconcelos, M. Linardi, J Power Sources, 137 (2004) 17-23

ACKNOWLEDGEMENTS

Dr S. Hietkamp (CSIR)
R. Rossouw (National Metrology Institute of South Africa)