Preparation and characterization of Pt-Sn/C and Pt-Ir/C catalysts for the electrochemical oxidation of ethanol in polymer electrolyte membrane fuel cell

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INTRODUCTION

Low temperature fuel cells with methanol or ethanol as the fuel present an environmentally friendly technology and are attracting considerable interest as a means of producing electricity. High surface area carbon supported Pt is recognised as the most active metal for ethanol oxidation, however the formation of CO-intermediates poison the Pt catalyst. Ethanol oxidation is a very complex reaction involving 12 electrons. The oxidation reaction of ethanol on the anode and cathode side of the fuel cell is as follows

Anode side:

$$C_2H_5OH + 12OH^- \longrightarrow 2CO_2 + 9H_2O + 12e^-$$

Cathode side:

$$3O_2 + 6H_2O + 12\,e^- \longrightarrow 12OH^-$$

Net reaction:

$$C_2H_5OH + 3O_2 \longrightarrow 3H_2O + 2CO_2$$

The investigation of anodic catalysts in ethanol fuel cells is focused on the development of a catalyst system which is able to break the C–C bond and oxidize the poisoning intermediates from ethanol oxidation at lower temperature.

EXPERIMENTAL WORK

Chemical deposition method using formic acid as reducing agent and the Electrochemical deposition method were used for the preparation of electro-catalysts

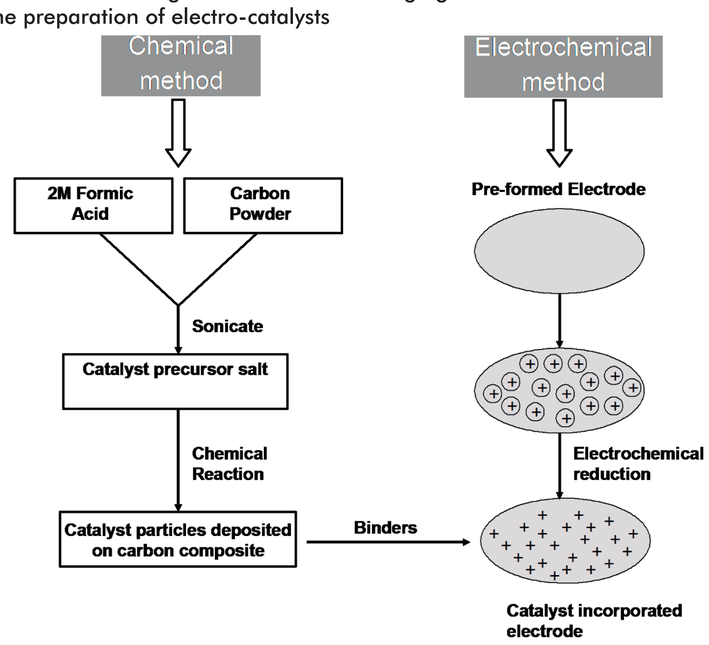

Figure 1: Schematic representation of the electro-catalysts deposition method

Table 1: Parameters for electro-deposition

Step	Potential (V)	Time (s)
1	-0.5	5
2	0.0	300

RESULTS

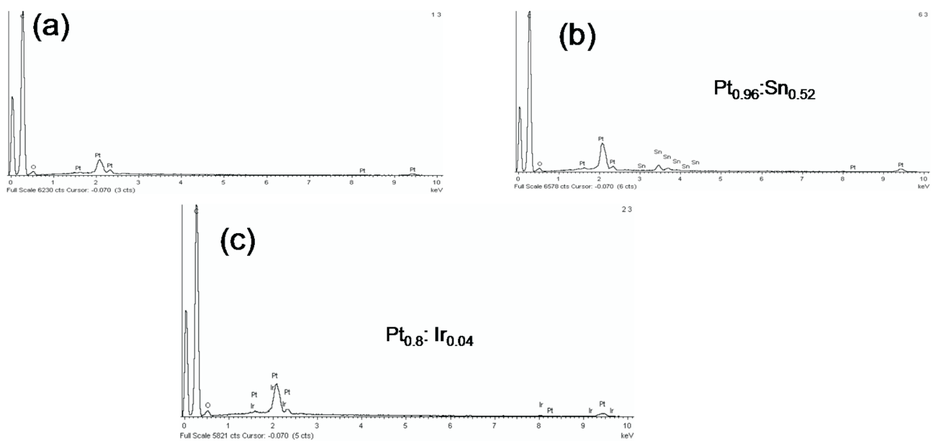

Figure 2: EDX profiles electro-catalysts prepared by the formic acid method (a) 20w% Pt/C, (b) 20wt% Pt-Sn/C, (c) 20wt% Pt-Ir/C

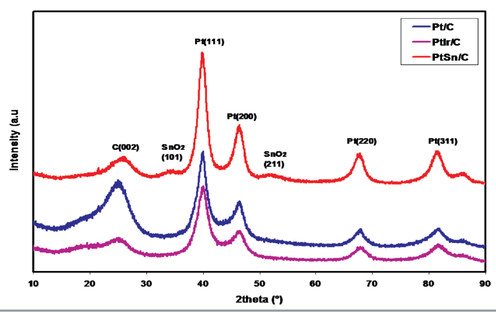

Figure 3: XRD SPECTRA, Cu-Ka source

Table 2: Crystallite size

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

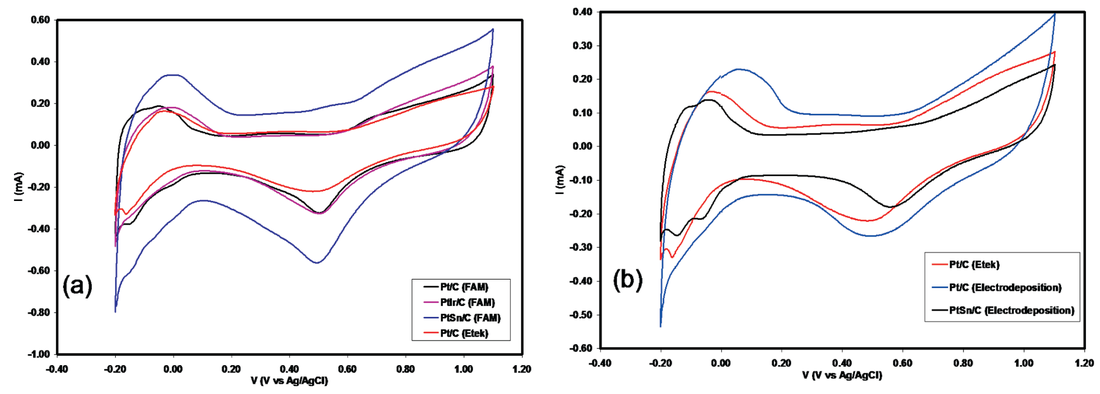

Figure 4: Cyclic voltammograms of electro-catalysts in 0.5M H_2SO_4 at 50mV/s and 25°C (a) -formic acid method and (b) electro-deposition method

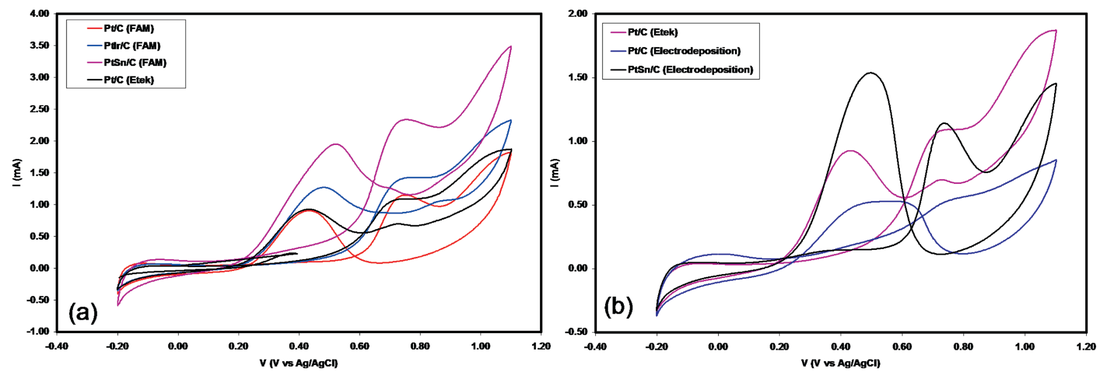

Figure 5: Cyclic voltammograms of electro-catalysts in 0.5M H_2SO_4 + 0.5M C_2H_5OH at 50mV/s and 25°C (a) -formic acid method and (b) electro-deposition method

CONCLUSIONS AND FUTURE WORK

- Electro-catalysts were successfully prepared by chemical and electrochemical methods.
- Electro-catalysts prepared by chemical method showed better performance than the ones that were electrochemically prepared.
- The commercial Pt/C and FAM Pt-Sn/C electro-catalysts were more efficient towards ethanol oxidation but were susceptible to CO poisoning.
- Addition of Sn and Ir to Pt/C shows a performance improvement to ethanol oxidation in both chemical and electrochemical methods.
- Membrane Electrode Assemblies will be fabricated using prepared electro-catalysts and tested for performance in direct ethanol fuel cell.

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