

EDTA Assisted Ce(III)/Pt Vulcan XC-72 Catalyst
Synthesis for
Direct Methanol Fuel Cell Applications

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Production of energy with fuel cells is an attractive energy conversion approach due to their high efficiency, low environmental impact, and their relatively flexible applications.¹ Particularly, direct alcohol fuel cells (DAFCs) are widely investigated to produce energy and utilized for industrial energy supply. In the DAFCs, electrocatalyst is the key component to enhance the fuel cell efficiency. It has been suggested that rare earth oxides, such as ceria (cerium oxide), can be used as co-catalyst because of their interesting chemical characteristics. It is also known that ceria has the oxygen storage capability (OSC) that improves the catalytic performance by storing oxygen during oxidation processes and releasing oxygen during reduction processes, leading to an enhancement in the performance of a DMFCs [12]. Some groups have found similar effect of ceria for methanol [15], ethanol [16], and ethylene glycol [17] oxidation.

Cerium modified Pt nanoparticles catalysts have been prepared using Ce(III)-ethylenediaminetetraacetic acid (EDTA) chemistry with an impregnation method of 20%Pt/Carbon Vulcan XC-72 (Pt/C). EDTA was used as a chelating agent to form a Ce(III) complex to achieve good dispersion of ceria on Pt/C while maintaining +3 oxidation state. Different Ce(III) to Pt atomic ratios have been examined to optimize the catalyst material. The catalyst samples were characterized by using various characterization techniques such as X-ray diffraction, high-resolution transmission electron microscopy, X-ray absorption spectroscopy, among others. Their catalytic activities for methanol oxidation in half-cell and direct methanol fuel cell systems were done. It has been found that the catalytic activity of nominal 6wt%Ce(III)/20wt%Pt/C exhibited better activities than 20wt%Pt/C and other Ce(III)/20wt%Pt/C compositions.

The power curves for the direct methanol fuel cell were determined by supplying 1.0 M methanol to the anode and 200 sccm oxygen at the cathode at various cell temperatures such as 25, 60, 75 and 90°C. The results are shown in Figures 1. The 20P0C system exhibited an open circuit voltage (OCV) of 0.370V, 0.464V, 0.467 and 0.498 V at 25, 60, 75, and 90°C, respectively. The 20P6C anode catalyst systems exhibited a 0.430 V, 0.495V, 0.497V and 0.500 V at 25, 60, 75 and 90°C, respectively. The higher OCV values shown by 20P6C anode catalyst systems at both temperatures indicate its higher methanol oxidation activity, consequently leading to higher fuel utilization at the anode and lower methanol crossover. In addition, the power vs. current curves were made for the anodes 20P0C and 20P6C at 25, 60, 75 and 90°C,

respectively. Figures 1A and 1B show that the 20P6C anode catalyst system exhibited higher power at a given current and at all fuel cell temperatures.

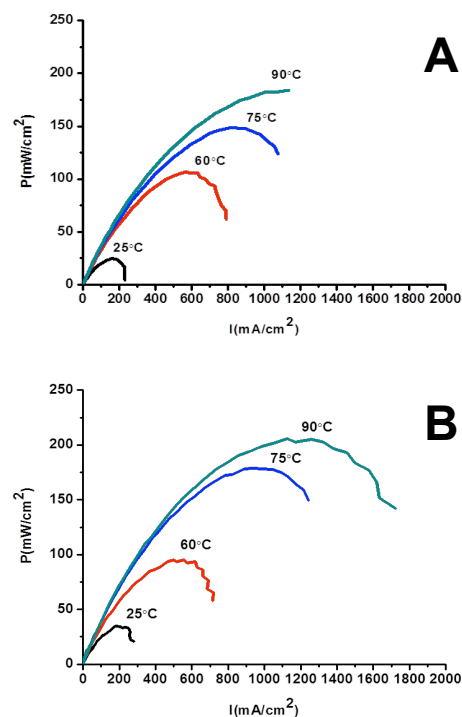


Figure 1. Direct methanol fuel cell, power curves of (A) 20P0C and (B) 20P6C as anode catalyst in single cell mode. Anode feed: 1.0 M methanol, 2.0 ml/min; cathode feed: air, 200 sccm; cell temperatures: 25, 60, 75 and 90 °C.

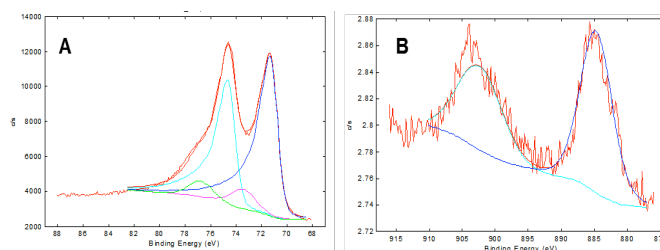


Figure 2. Curve-fitted high-resolution X-ray photoelectron spectroscopy spectra for the (A) Pt 4f and (B) Ce 3d binding energy regions for Vulcan-Pt-Ce(III) catalyst.

Acknowledgments

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