Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 138 (2017) 229–234

Energy Procedia

www.elsevier.com/locate/procedia

2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies
2017 AEDCEE, 25-26 May 2017, Bangkok, Thailand

Catalytic activity of various platinum loading in acid electrolyte at 303 K

Chakkrapong Chaiburi[a]*, Viktor Hacker[b]

[a]*Department of Chemistry, Faculty of Science, Thaksin University (Phatthalung Campus), 222 Moo 2, Ban Prao, Pa Payom, Phatthalung, 93210, Thailand*
[b]*Institute of Chemical Engineering and Environmental Technology, Fuel Cell Systems Group, Graz University of Technology, NAWI Graz, Inffeldgasse 25C, 8010 Graz, Austria*

Abstract

The aim of this work is to determine the optimum platinum (Pt) loading on the surface of glassy carbon. By measuring four different Pt loading electrocatalysts, the electrochemical surface area (ECSA), the mass activity (MA), the roughness factor (r_f) and the kinetic current (i_k) was observed. The specific activity (SA) increased for decreasing Pt loading. At high Pt loadings, aggregation of Pt in the active layer was observed.

Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.

Keywords: Pt catalyst loadings; electrochemical surface area; mass activity; specific activity; fuel cell

1. Introduction

Platinum (Pt) is the most active electrochemical catalyst toward many electrochemical reactions, such as the anode of the oxidation and the cathode of the reduction in proton exchange membrane fuel cells (PEMFCs). The information on the electrochemical surface area (ECSA) of Pt loading is essential to derive the catalytic activity for evaluation. This is important to understand the relationship between various Pt loading and catalytic activity. The

* Corresponding author. Tel.: +66-(0)74-609600.
E-mail address: chakkrapong@tsu.ac.th, kchakkrapong@yahoo.com

1876-6102
Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.
10.1016/j.egypro.2017.10.155

ECSA of various Pt loading electrocatalysts, consist of single crystalline and polycrystalline Pt nanoparticles as well as being carbon-supported. This approach is mainly obtained by cyclic voltammetry (CV). Then, the roughness factor (r_f) is calculated. The catalytic activity is determined by an oxygen reduction reaction (ORR). After that, the kinetic current (i_k), mass activity (MA) and specific activity (SA) are calculated.

2. Materials and Methods

2.1 Reagents

Nanopure water (18 MΩ cm, Barnstead Nanopure), ultra high purity nitrogen (N_2) and oxygen (O_2) were used during the experiments. 30 wt. % Pt/C powders were from E-Tek. H_2SO_4 solution was purchased from Aldrich.

2.2 Physical characterization methods

The morphology of 30 wt. % Pt/C commercial catalysts (E-Tek) was determined using scanning electron microscopy (SEM). The SEM is a type of electron microscope that can produce high resolution images of a sample surface. Energy dispersive X-ray spectroscopy, (EDX) was used to measure the element compositions of Pt/C catalysts.

2.3 Electrochemical measurements

All electrochemical measuring techniques were carried out with standard three-electrodes at 303 K. The 0.10 M H_2SO_4 working electrolyte was prepared from nanopure water (18 MΩ cm, Barnstead Nanopure). The reference electrode was used as a reversible hydrogen electrode (RHE) and a platinum electrode was used as the counter electrode. The working electrode was glassy carbon. Ultra high purity nitrogen (N_2) and oxygen (O_2) were employed. The catalysts were carried out on commercial 30 wt % Pt supported on vulcan carbon XC-72, Pt/C (E-Tek). For the rotating disk electrode, (RDE), the catalyst ink was prepared on a glassy carbon electrode where ∅ was equal to 5 mm and the surface area was equal to 0.196 cm^2. The working electrode Pt-loadings were 7 μg_{Pt} cm^{-2}, 14 μg_{Pt} cm^{-2}, 28 μg_{Pt} cm^{-2} and 56 μg_{Pt} cm^{-2}. The solution of the catalyst ink was prepared by mixing ratio of isopropanol and nanopure water in the ratio 7:3. The catalyst ink was then sonicated for 20 minutes in an ultrasonicator. Then, a 5 µl of catalyst ink was pipetted and loaded on to the clean working electrode. The glassy carbon electrode with a flattened drop was rotated at 700 rpm until the film is dry (see Fig. 1) [1].

Fig. 1. Flattened drop on glassy carbon