한국신·재생에너지학회 2006년도 추계학술대회논문집 pp.411~412

전기 환원법을 이용한 고분자 전해질 연료전지용 PtRu 전극제조

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Preparation of PtRu catalysts Using Galvanostatic Pulse Electrodeposition on Nafion(Na+) bonded Carbon Layer for PEMFC

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Key words :Proton exchange membrane(PEM) fuel cell, galvanostatic pulse electrodeposition, Platinum-Ruthenium, CO tolerance

Abstract : PEM(proton exchange membrane) fuel cell have been receiving considerable interest as power source because of high-energy efficiency. However by using reforming hydrogen gas, CO poisoning occur in anode. To improve CO tolerance, PtRu catalysts were prepared by galvanostatic pulse electrodeposition. The composition(atomic ratio) of catalysts are controllable by using different concentrations of PtRu solutions. Also,the particle sizes of PtRu on carbon are similar to about 3.5 ~ 4 nm regardless of concentration.

1. Introduction

A PEM fuel cell operating with high-purity hydrogen as fuel show good performance over a wide range of conditions. However, in a hydrogen-based economy, cheap hydrogen is required[1]. This hydrogen gas can be produced with the aid of the reforming of an organic fuel, like natural gas, methanol or a gasoline fraction. The reforming process leads to the production of a mixture of hydrogen, carbon dioxide, carbon monoxide and nitrogen, whose final composition depends on the starting chemical in the reforming process. The common point of view with regard to the mechanism of the poisoning of platinum is blocking of sites available for the hydrogen adsorption by particles of CO, because the strength of the Pt-CO bond is higher when compared with the Pt-H bond. This hinders the dissociative adsorption of hydrogen on platinum and its subsequent ionization.[2] Platinum-Ruthenium alloy catalysts were produced in order to improve the CO tolerance of platinum.

The objective of the present work is to use galvanostatic pulse electrodeposition as an electrochemical technique to prepare PtRu catalysts in different concentrations of PtRu solutions.

2. Experimental

Solutions were prepare using K_2PtCl_4 , and K_2RuCl_5 dissolved in 0.5 M NaCl. Also, to avoid the formation of ruthenium oxides at counter electrode, ethyl alcohol put in solutions. The nine concentrations of PtRu were selected : 1) 10 mM K_2PtCl_4 + 10 mM K_2RuCl_5, 2) 10 mM K_2PtCl_4 + 20 mM K_2RuCl_5, 3) 10 mM K_2PtCl_4 + 40 mM K_2RuCl_5, 4) 20 mM K_2PtCl_4 + 10 mM K_2RuCl_5, 5) 20 mM K_2PtCl_4 + 20 mM K_2RuCl_5, 6) 20 mM K_2PtCl_4 + 40 mM K_2RuCl_5, 7) 40 mM K_2PtCl_4 + 40mM K_2RuCl_5, 8) 40 mM K_2PtCl_4 + 20 mM K_2RuCl_5, 9) 40 mM K_2PtCl_4 + 10 mM K_2RuCl_5

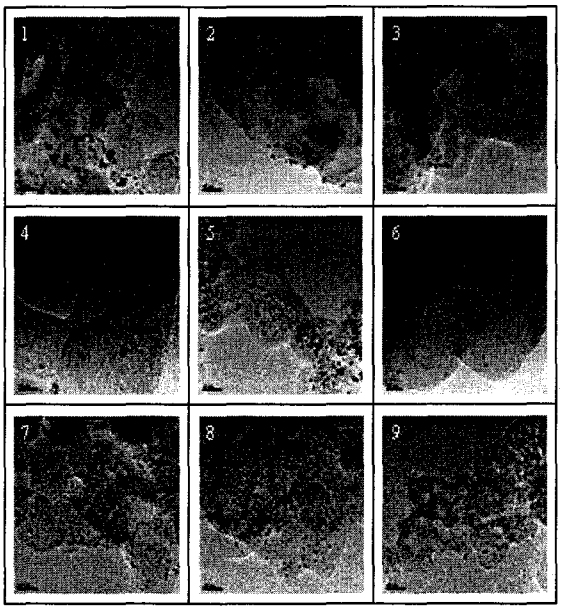
Nafion bonded carbon electrodes were prepare by Vulcan XC-72 carbon powder and 5 wt% Nafion solution were mixed with isopropyl alcohol, Glycerol, which produces hydrophilic layer, and NaOH in order to change H-form of Nafion into the Na^+ form. The mixture was applied on E-TEK GDL(Gas Duffusion Layer) by spraying. The time program for galvanostatic pulse electrodeposition was 0.01 s (t_{on}) at j=300 mA/cm^2, and 0.1 s (t_{off}) at j=0 mA/cm^2. Electron probe micro analysis (EPMA) was ewmployed to measure the atomic ratio. And the particle size of PtRu was observed with a transmission electron microscope.

3. Rusults

We prepared PtRu catalysts in different concentrations of PtRu solutions by galvanostatic pulse electrodeposition. The Atomic ratios of electrodeposited PtRu catalysts are in table 1 The distributions of PtRu particle sizes were made by counting the particle s in TEM images as shown in picture 1. The particle sizes of PtRu on carbon are similar to c regardless of concentration.

Table 1 Pt : Ru atomic ratio

Concentration of PtRu solution	Pt : Ru atomic ratio (EDX)
10 mM Pt + 10 mM Ru	60 :40
10 mM Pt + 20 mM Ru	45:55
10 mM Pt + 40 mM Ru	35:65
20 mM Pt + 10 mM Ru	75:25
20 mM Pt + 20 mM Ru	60:40
20 mM Pt + 40 mM Ru	45:55
40 mM Pt + 10 mM Ru	85:15
40 mM Pt + 20 mM Ru	70:30
40 mM Pt + 40 mM Ru	60:40



Picture. 1 TEM Image (1:10 mM Pt + 10 mM Ru, 2: 10 mM Pt + 20 mM Ru, 3: 10 mM Pt + 40 mM Ru , 4: 20 mM Pt + 10 mM Ru, 5:20 mM Pt + 20 mM Ru, 6: 20 mM Pt + 40mM Ru, 7: 40 mM Pt + 10 mM Ru, 8: 40 mM Pt + 20 mM Ru, 9: 40 mM Pt + 40 mM Ru)

4. Conclusion

In this work we have prepared PtRu catalysts on the surface of carbon by galvanostatic pulse electrodeposition. In this way, it is possible to decrease the thickness of the catalyst layer and increase the catalyst utilization. Moreover, the composition(atomic ratio) of catalysts are controllable by using different concentrations of PtRu solutions. The particle sizes of PtRu on carbon are similar to regardless of concentration.

References

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