

Preparation of Pt/C Catalyst with Solid Phase Reaction Method

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Abstract: The Pt/C catalyst was prepared with solid phase reaction method (Pt/C(S)) for the first time. Its performances were compared with that prepared by the traditional liquid phase reaction method. The results demonstrate that the electrocatalytic activity of Pt/C catalyst with solid phase reaction method for methanol oxidation is higher than that with liquid phase reaction method. XRD and TEM measurements indicate that the Pt/C(S) possesses low crystalline extent and small particle size.

Keywords: Solid phase reaction, fuel cell, Pt/C catalyst.

Pt is the most effective catalyst in the proton exchange membrane fuel cell. At the present time, the Pt/C catalyst is generally prepared using liquid phase reaction method and called Pt/C(L). In this work, Pt/C catalyst was prepared with the solid phase reaction method and we called this catalyst Pt/C(S). The electrocatalytic activities for methanol oxidation and the morphologies for both catalysts were studied using cyclic voltammetry, XRD and TEM techniques.

The procedure for preparation of Pt/C(S) is as follows. The active carbon was mixed with the $\text{H}_2\text{PtCl}_6 + \text{NaOH}$ solution, dried, mixed with a solid reductant and then abraded for 4-5 hours. Finally, it was washed sequentially with acid, water and dried at 90°C . For comparison, Pt/C(L) was prepared by reduction of H_2PtCl_6 with NaBH_4 in the solution. The Pt content of both catalysts is 20wt%.

The thin film electrodes were prepared using the method reported by Schmidt *et al.*¹. The glass carbon electrode was polished. Then, Pt/C catalyst and alcohol suspension was sprayed onto the electrode surface. After the evaporation of the alcohol, the Nafion solution (5wt%) was sprayed on the surface of Pt/C catalyst. The apparent area of the glass carbon electrode is 0.13 cm^2 . The Pt loading was $28 \mu\text{g}/\text{cm}^2$.

The electrochemical measurements were performed with CHI 600 potentiostat (CHI Co.) and a traditional three-electrode cell at 25°C . The Pt/C catalyst modified glass carbon electrode was used as working electrode. The saturated calomel electrode (SCE) and Pt wire were used as reference and auxiliary electrode, respectively. The solution used for the electrochemical measurements was $0.5 \text{ mol/L CH}_3\text{OH} + 0.5 \text{ mol/L H}_2\text{SO}_4$ solution.

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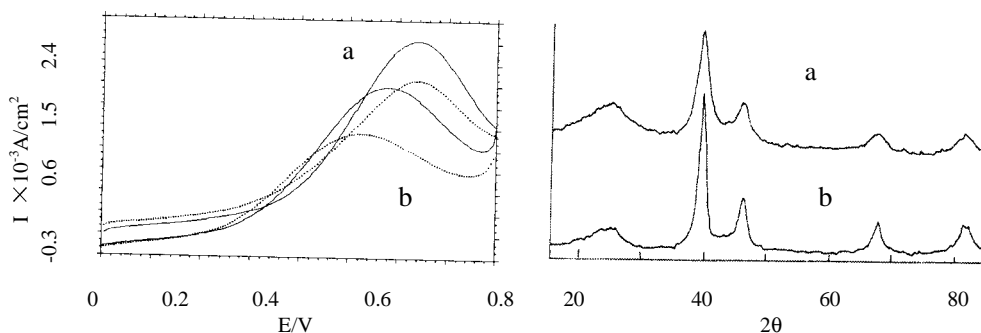
Figure 1 is the cyclic voltammograms(CVs) of methanol at the Pt/C(S) (**Curve a**) and Pt/C(L) (**Curve b**) electrodes. It is observed from **Figure 1** that for the positive scan, the oxidation peaks of methanol at both Pt/C(S) and Pt/C(L) electrode are located at 0.64 V. However, the peak current density at the Pt/C(S) electrode (**Figure 1, Curve a**) is $2.2 \times 10^{-3} \text{ A/cm}^2$, which is much higher than that at the Pt/C(L) electrode ($1.5 \times 10^{-3} \text{ A/cm}^2$) (**Figure 1, Curve b**). It demonstrates that the electrocatalytic activity of Pt/C(S) for methanol oxidation is much higher than that of Pt/C(L).

Figure 2 is the XRD curves of Pt/C(S) (**Curve a**) and Pt/C(L) (**Curve b**). **Figure 2** showed that the diffraction peaks of Pt/C(L) (**Figure 2, Curve b**) are higher and narrower than that of Pt/C(S) (**Figure 2, Curve a**). It illustrates that the crystallinity of Pt/C(L) is higher than that of Pt/C(S). TEM measurements showed that the average particle size of Pt in Pt/C(S) is less than 3 nm, while it is about 11 nm in Pt/C(L). Thus, the specific surface area of Pt in Pt/C(S) is larger than that in Pt/C(L).

It is well known that low crystallinity and small particle size of the catalyst is favorable for the electrocatalytic activity. That is the reason, why the electrocatalytic activity of Pt/C(S) for methanol oxidation is better than that of Pt/C(L). The situation may be the same for hydrogen oxidation. Further work is in progress.

Figure 1 CVs of methanol at (a) Pt/C(S) and (b) Pt/C(L) electrodes

Figure 2 XRD of (a) Pt/C(S) and (b) Pt/C(L)



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Reference

1. T. J. Schmidt, H. A. Gasteiger, R. J. Behm, *J. Electrochem. Soc.*, **1999**, *146*, 1296.

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