The Role of Au in Pt/Au and Pt/Ru/Au Alloy Nanoparticles in Methanol Electrooxidation

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Introduction

Although many researches had been concentrated in this field, the low activity of catalyst still remained to be solved. Previously, we reported the chemical and electronic effect of Ni in Pt/Ni and Pt/Ru/Ni alloy and their temperature dependent catalytic activity. In this paper, we investigated the role of Au in Pt/Au and Pt/Ru/Au alloy nanoparticle and in thin film electrode in methanol electro-oxidation.

Experimental

Pt alloy nanoparticles were synthesized by reduction of $NaBH_4$ combined with freeze-drying without any heat treatment. Thin film electrodes were prepared by co-sputtering system using each metal target. Alloy formation and the particles size were confirmed by XRD and TEM. The surface chemical states were analyzed by XPS. Electrochemical measurement were conducted using a three electrode cell in which a Pt gauze and Ag/AgCl (*sat.* KCl) were used as a counter and a reference electrode, respectively.

Results and Discussion

Figure 1 shows the voltammogram of Pt/Au (1:1), (3:1) and Pt only in 2 M CH_3OH + 0.5 M H_2SO_4 solution. When compared current based on the Pt mass, not total alloy mass, the current of Pt/Au alloys exceeded that of Pt only. It means that the activity of Pt for methanol electrooxidation was increased by alloying with Au. Figure 2 shows XPS spectra of Au*4f* in Pt/Au (1:1) alloy nanoparticles. The Au4f$_{7/2}$ and 4f$_{5/2}$ lines appear at ~84 and ~88 eV, respectively. The comparisons of binding energies indicate that Au is present in the zerovalent metallic state without surface oxide in all Pt/Au alloys having different atomic ratio. There is no evidence to conclude that Au is involved in bifunctional mechanism because this involves the presence of metal oxides on the surface. For this reason, the role of Au in Pt-based alloy will be discussed in view of electronic effect. Finally, we suggest the Au containing ternary catalysts for use of DMFC anode.

References

[1] Kyung-Won Park, Jong-Ho Choi, Bu-Kil Kwon, Seol-Ah Lee, Y. -E. Sung, Heung-Yong Ha, Seong-Ahn Hong, Hongsun Kim, and Andrzej Wieckowski, *J. Phys. Chem. B*, 106 (2002) 1869.

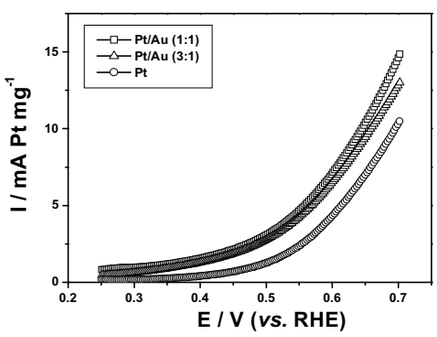

Figure 1. Voltammograms of Pt/Au (1:1), (3:1) and Pt only in 2 M CH_3OH + 0.5 M H_2SO_4

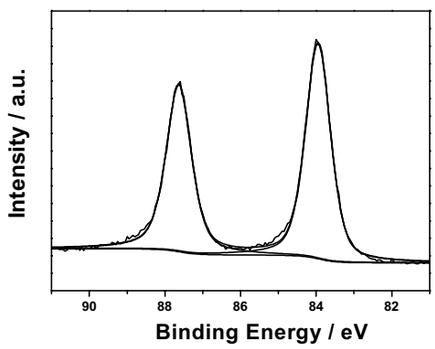

Figure 2. X-ray photoelectron spectra of Au*4f* in Pt/Au (1:1) nanoparticle