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Electrocatalytic Activity of Platinum Particles Electrodeposited onto Poly(vinylpyridine) Films

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Abstract: The electrocatalytic properties of platinum microparticles incorporated into poly-(vinylpyridine) (PVP) films, a conducting polymer with good conductivity and stability, were investigated for hydrogen evolution and formic acid electrooxidation in acidic media. It was found that the catalytic effects depend mainly on the size and amounts of the platinum microparticles dispersed in the polymer layer.

Keywords: Electrocatalysis, platinum, poly(vinylpyridine), formic acid, hydrogen.

Conducting polymers with porous structure and high surface area are often considered to be useful as supporting materials for the incorporation of dispersed noble metal catalysts and development of high performance electrocatalytic materials. Some conducting polymers, especially polyaniline[1-3], polypyrrole[4, 5] and their derivatives are usually used as matrices to incorporate noble metal catalysts in the application for electrooxidation of small organic molecules. By comparison, few attention is paid to poly(vinylpyridine) (PVP), another conducting polymer with good conductivity and stability, to be used as supporting material to incorporate dispersed noble metal particles for the electrocatalytic applications.

Poly(vinylpyridine) was first synthesized on the glass carbon (GC) electrode, and then the platinum particles were electrodeposited onto the poly(vinylpyridine)-modified GC electrode in the solution of 0.003 mol/L H_2PtCl_6 + 0.5 mol/L H_2SO_4. The amounts of the dispersed platinum were determined from the charges passed in the reduction processes. All the electrochemical experiments were conducted by using a CHI650A Potentiostat.

The cyclic voltammogram (CV) of GC/PVP and GC/PVP/Pt electrode (Pt content: 14μg/cm^2) in 0.5 mol/L H_2SO_4 solution is shown in **Figure 1**. Compared with the redox behavior on GC/PVP electrode, the peaks of hydrogen ionization and oxygen adsorption on the GC/PVP/Pt electrode become much remarkable in the redox process, which clearly demonstrates the electrocatalytic effect of platinum particles dispersed in the PVP matrix. On the other hand, there is no clear peak of adsorbed hydrogen in the potential

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ranges of hydrogen ionization on the GC/PVP/Pt electrode. This character of hydrogen adsorption/desorption often appears when small metal particles were deposited onto supporting materials[6]. Therefore, the results obtained on the GC/PVP/Pt electrode indicate that the hydrogen adsorption process may be mainly determined by the particle size of platinum dispersed in the PVP layer.

Figure 2 shows the steady state polarization curves of electrooxidation of formic acid on GC/PVP/Pt electrode (curve 1, Pt content: 12μg/cm^2) and platinized platinum electrode (curve 2) in the 0.5 mol/L HCOOH + 0.5 mol/L H_2SO_4 solution. It is clearly seen that the electrooxidation potential of formic acid on GC/PVP/Pt electrode shifts negatively compared with that on the platinized platinum electrode. Moreover, it should be noted that the electrocatalytic activity of platinum particles electrodeposited onto the PVP matrix is higher than that of platinized platinum in the region of low current densities. On the other hand, the two lines have different slopes, as shown in **Figure 2**. It means that the electrocatalytic mechanism of formic acid electrooxidation on the GC/PVP/Pt and platinized platinum electrodes is different.

Figure 1 Cyclic voltammogram of GC/PVP electrode (solid line) and GC/PVP/Pt electrode (dotted line) (v = 50mV/s)

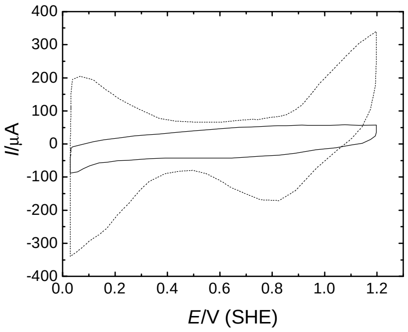
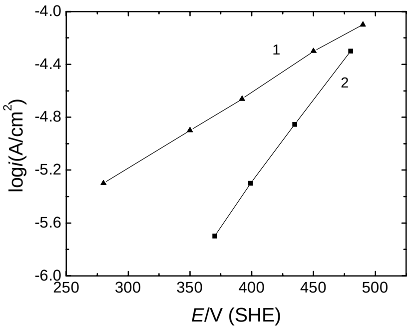


Figure 2 Steady state polarization curves of HCOOH electrooxidation on (1)GC/PVP/Pt electrode and (2) platinized Pt electrode



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