

75b Electrochemical Oxidation Kinetics on Pt/RuO₂ Nanorods in Formic Acid Solutions

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The motivation of this study is to search for a bifunctional catalyst with minimum amount of platinum loading for formic acid fuel cell. The bifunctional catalyst is prepared with an electroplated platinum thin layer on the ruthenium dioxide nanorods (RuO₂NR). The RuO₂NR was vertically grown on a LiNbO₃(100) substrate in a cold-wall CVD reactor using ruthenocene (Strem Chemicals) as precursor. Height of these rods is around 1000 nm and diameter 50-100 nm. Specific surface area of RuO₂NR is around 400 m²g⁻¹. The deposited mass per unit area of RuO₂NR is 0.25 mgcm⁻², and that of Pt is 0.05 mgcm⁻². The cyclic voltammograms between -0.2 and 0.9 V (vs Ag/AgCl) indicate that this Pt/RuO₂NR catalyst has high catalytic effect in formic acid oxidation, reasonable catalytic effect in ethyl alcohol oxidation, and poor for methanol oxidation. Hence we study the oxidation kinetics of this catalyst in formic acid. The electro-oxidation rate of 0.1 M formic acid in potentiostatic measurement at 25°C indicates that the current density decreases quickly first, slows down after 20 minutes, and reaches a steady-state value after 4 hours. The decline of current density is attributed to the adsorbed CO accumulation. Nonetheless the catalyst demonstrates respectable current density after significant CO poisoning. The current density measured at steady state is around 0.3 mAcm⁻² at 0.3 V (vs Ag/AgCl). The Tafel plot of Pt/RuO₂NR electrode is measured by subtracting the background current in the same electrolyte without formic acid from the current in the electrolyte with a prescribed formic acid concentration. The polarization curve is recorded in the backward sweep from 0.0-0.7 V (RHE) at sweep rate 0.1 mVs⁻¹. The Tafel slope of the polarization curves of electrolytes containing 0.1, 0.3, 0.5, 1.0, 2.0 M formic acid and fixed 0.5M H₂SO₄ at 25°C is 126 mVdec⁻¹. The power dependence of formic acid in its electrooxidation rate is 0.58. The influence of acid concentration on the Tafel slope is recorded between 0.035 and 1.0M H₂SO₄. The value of Tafel slope slightly increases with the sulfuric concentration. The power dependence of H₃O⁺ concentration in the electrooxidation rate is 1.0. The overall kinetics will be discussed in the presentation.