Electrooxidation of Formic Acid on Poly(vinylferrocenium)-Supported Pt Nanoparticles

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Direct fuel cells (DFCs) using liquid fuels directly as a fuel without a reforming step have received much attention in the past decade because liquid fuels are very easy to store, transport and refill, and allow for compact design that can offer up to 10 times the energy density of rechargeable batteries. In addition, DFCs can operate at ambient temperature, reducing thermal management challenges for small systems. These advantages make the technology attractive to the rapidly increasing need for portable power sources \cite{1}. Recently, direct formic acid fuel cell (DF AFC) has been the focus of continuous efforts, because of its advantages over direct methanol fuel cell including higher theoretical open circuit potential and lower fuel crossover \cite{2}. Following their successful implementation in the first DFAFC systems, Pt-based catalysts have been widely studied, and continue to be an important aspect of DFAFC anode catalyst research \cite{3}.

In the present study, we describe electro oxidation of formic acid on poly(vinylferrocenium) supported Pt nanoparticles (Pt/PVF\textsuperscript{+} catalyst system). The polymer was electrodeposited on the electrode surface by the electro oxidation of 1.0 mg mL\textsuperscript{-1} PVF solution in methylene chloride containing 0.1 M TBAP at + 0.7 V vs. Ag/AgCl. Pt particles were incorporated into the polymer matrix via cyclic voltammetric scans in aqueous 2 mM K\textsubscript{2}PtCl\textsubscript{4} solution without supporting electrolyte. In this step, Pt is in complex form and does not show catalytic activity. In order to reduce the Pt species, polymer-coated electrode containing Pt complex was immersed in 0.1 M hydrazine solution stirred continuously at open circuit \cite{4}. Scanning Electron Microscopy (SEM) images revealed that the diameters of the Pt particles were approximately 80 nm. The Pt/PVF\textsuperscript{+} catalyst system showed catalytic activity towards formic acid oxidation. The system was also tested in a single fuel cell configuration at ambient temperature and atmospheric pressure. Nafion\textsuperscript{®} membrane was used in the direct formic acid fuel cell (DFAFC) construction. The anode was Pt/PVF\textsuperscript{+} catalyst system prepared using Pt foil electrode (1cm\times1cm). Pt black-coated Pt electrode was used as the cathode material. 6 M formic acid solution containing 0.5 M H\textsubscript{2}SO\textsubscript{4} was used as the fuel and 0.5 M H\textsubscript{2}SO\textsubscript{4} solution which was saturated by pure O\textsubscript{2} gas was used as the oxidant. The system was tested with a homemade single cell with a working area of 1 cm\textsuperscript{2}. The cell performance was also compared with direct methanol fuel cell (DMFC) construction.

REFERENCES
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