

TUESDAY, AUGUST 23, 2005, P.M.

SESSION 22A: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

MATERIALS FOR PEMFC

Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM

Room: Imperial Ballroom 5

Chairmen: J. ZHANG, NRC Institute for Fuel Cell Innovation, Canada

E. ANDRUKAITIS, Defence Research & Development Canada, Canada

PAPER 22A.1 — 14:00

EVALUATION OF THE $\text{Fe}^{3+}/\text{Fe}^{2+}$ REDOX FUEL CELL CATHODE COUPLE.

F. MORAW, K. FATIH, F. GIRARD, NRC Institute for Fuel Cell Innovation, Canada and

D. P. WILKINSON, University of British Columbia, Canada

The use of redox fuel cells in which oxygen is replaced by other oxidants such as ferric ions can have significant advantages [1-3]. For example, the cathodic reaction rate (e.g., exchange current density) can be increased by several orders of magnitude compared to the oxygen reduction reaction, and platinum group metal (PGM) catalysts are not required. As a result of the higher aqueous solubility of the oxidant in a redox fuel cell compared to that of oxygen the rate of mass transfer (e.g., limiting current density) is greater by several orders of magnitude. The redox fuel cell can achieve high efficiencies and has other fuel cell advantages. The main issue with the redox fuel cell cathode is the regeneration of the oxidant where low conversion efficiencies are achieved even with platinum group metal (PGM) catalysts.

In the work discussed here the $\text{Fe}^{3+}/\text{Fe}^{2+}$ redox fuel cell cathode is characterized over a range of electrolyte concentrations and operating conditions, and electrode materials. Cyclic voltammetry and electrochemical impedance spectroscopy are mainly used for electrochemical characterization and mechanistic determination of the cathode redox couple. Further characterization with selected compositions and materials is done in a redox fuel cell (hydrogen – $\text{Fe}^{3+}/\text{Fe}^{2+}$). The mechanism and the advantages and disadvantages of the fuel cell redox cathode are discussed with respect to other approaches and other redox couples.

PAPER 22A.2 — 14:20

PT-BI INTERMETALLIC NANOPARTICLES AS ELECTROCATALYSTS FOR OXYGEN REDUCTION.

D. XIA, College of Environmental and Energy Engineering, China

Pt-Bi intermetallic Nanoparticles was prepared by the polymer-anchor method. The electron micrographs shows that the dimensions of particles sharply distribute in the range of about 3-6 nm. The elemental ratio of Pt/Bi in the bimetallic particles is estimated by the electron probe microanalysis method. Pt-Bi intermetallic Nanoparticles shows a higher activity for the ORR than pure Pt. No significant dependence of the oxidation currents on the rotating speed of the electrode could be observed in the presence of methanol. This clearly indicates that the Pt-Bi is inactive to methanol.

PAPER 22A.3 — 14:40

GAS DIFFUSION ELECTRODE WITH ZrP-NAFION ELECTROLYTE FOR PEMFC OPERATION AT 80-120°C.

Z. XIE, K. SHI, T. NAVESSIN, R. CHOW, NRC Institute for Fuel Cell Innovation, Canada and

S. HOLDCROFT, Simon Fraser University, Canada

The incorporation of solid proton conductor into the structure of bulk Nafion membrane has been shown to improve the performance of PEMFCs greatly. It would be highly desirable to develop effective GDE and MEA fabrication procedure to extend the benefits from bulk membrane materials into the catalysts structure. One promising strategy is to incorporate proton conductor into distributed PFSA electrolytes within catalysts layer structure and consequently improve the high temperature performance of whole MEA. Zirconium layered metal phosphate is promising solid proton conductor and has been widely studied as a component to increase proton conductivity of membrane for high temperature fuel cell. Here, we present an experimental studies on gas diffusion electrodes with ZrP modified Nafion ionomer in catalysts layer.

Gas diffusion electrodes for PEMFCs were fabricated via impregnation of Nafion solution with zirconyl chloride and 1 M phosphoric acid at 80°C. The composite electrolytes in catalyst layer had a ZrP content of 10% by weight. The GDEs were characterized by SEM/EDX analysis, ionic conductivity measurement, and single cell testing. The physical and electrochemical performance of ZrP-Nafion GDEs was compared with those of conventional Nafion ionomer GDE under varied temperature (80 to 120°C) and relative humidity (100 to 25%). The experimental research offers an approach to improve the ionic conductivity and/or water retention within catalyst layer.

PAPER 22A.4 — 15:00

ELECTROCATALYTIC ACTIVITY OF ORDERED INTERMETALLIC PtSb FOR ETHANOL ELECTROOXIDATION.

L. ZHANG and D. XIA, College of Environmental and Energy Engineering, China

The ethanol electrooxidation at PtSb ordered intermetallic electrode surface has been investigated using cyclic voltammetry. The results are compared to those at a polycrystalline platinum electrode surface. It was found that in ethanol containing electrolyte solution the onset potential for ethanol at PtSb is shifted to more negative potentials and the PtSb catalyst has about 6 times higher current density for ethanol oxidation than Pt. Thus the PtSb electrode exhibits superior properties in 0.5 mol/L- H_2SO_4 + 0.25 mol/L- $\text{CH}_3\text{CH}_2\text{OH}$ when compared to polycrystalline platinum in terms of ethanol oxidation onset potential and current density. Part of the dynamic parameters of the electro-catalytic oxidation of ethanol on Pt and PtSb electrodes are obtained through the cyclic voltammetry of different scanning speed. The results showed that the electron exchange coefficient (α) for $\text{C}_2\text{H}_5\text{OH}$ oxidation on PtSb electrode was much higher than that on Pt electrode.

COFFEE BREAK — 15:20 – 15:40