CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

S0908

Project Title

Feasibility of HEM Fuel Cells Today and Tomorrow: Comparing Performance and Economic Viability of Cataylsts in HEM Fuel

Abstract

Objectives/Goals

We compared nickel and silver in their respective reactions (anodic and cathodic) to platinum standard to determine their economic viability in HEM fuel cell. We hypothesized that nickel and silver, in their own respective reactions, are more economically viable than platinum in a HEM fuel cell.

Methods/Materials

Using a three rotating disc electrode (RDE) apparatus we establish the feasibility of our catalysts in a HEM fuel cell. We cleaned and polished Teflon-coated glass-carbon electrodes. Next we coated the electrode with nickel and then Nafion for the hydrogen oxidation reaction (HOR). We repeated the steps using silver instead of nickel for the oxygen reduction reaction (ORR). We sprayed the anode with an ink solution containing nickel on a gas diffusion layer and the cathode with platinum. The electrodes and the polymer membrane were placed in a molar solution of KOH. After drying the parts they were assembled into a membrane electrode assembly (MEA) and cold pressed at 3/4 metric tons. The MEA was tested in a single cell module. This was repeated for silver cathode.

Results

In RDE results the HOR with nickel preformed at 12.5% of platinum and silver performed at 0% of platinum's performance. Conversely in the ORR, silver performed at 72.7% of platinum while nickel performed at 54.5%. Thus nickel was used in the anode (HOR) and silver was used in the cathode (ORR). The fuel cell test results demonstrated that at 0.8V, Platinum performed at 116mW/cm^2 and 130mA/cm2. In the HOR nickel preformed at 23mW/cm^2 and 31.4mA/cm^2. In the ORR silver performed at 118mW/cm^2 and 190mA/cm^2. We computed that platinum costs $19.66/mW per electrode, nickel costs $0.0000188/mW in the anode, and silver costs $0.0000217/mW as cathode.

Conclusions/Discussion

Our results strongly support our hypothesis. Nickel did not perform as well as platinum in the anode, however nickel is less expensive and a non precious metal. Silver, on the other hand, outperformed platinum in the ORR. This was a remarkable breakthrough for HEM fuel cells because silver performed better than platinum in the cathode. The data shows that nickel and silver are both highly economic and viable catalysts to utilize in a HEM Fuel Cell. Our research has the potential to provide an alternative eco-friendly energy that can revolutionize the renewable energy market.

Summary Statement

Our project involves the comparison and evaluation of the economical viability of alternative catalysts, nickel and silver, to replace the industrial standard of platinum in a Hydroxyl Exchange Membrane fuel cell.

Help Received

Laboratory equipment used under the supervision of Doctor Yushan Yan, University of California at Riverside graduate students, Kurt Jensen and Shaun Alia for their guidance. A debt of gratitude to our beloved parents.