NOVEL HYBRID CATALYSTS CONTAINING METAL CHELATE COMPOUNDS WITH TUNABLE ELECTROCHEMICAL ACTIVITY

Rongrong Chen, Ph.D., Research Associate Professor of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI

Contact Information:
Email: rochen@iupui.edu
Phone: (317) 274-4280
Website: http://www.engr.iupui.edu/me/faculty/~rchen
Address: 723 W. Michigan Street (SL 260M), Indianapolis, IN 46202

Industry Sector(s): Anion Exchange Membrane Fuel Cell Technologies

Opportunity Overview

The performance of Anion Exchange Membrane Fuel Cells (AEMFC) is only modest compared to the state of the art, Proton Exchange Membrane Fuel Cell (PEMFC’s). Designing electrodes with enhanced gas diffusion and optimal mass and charge transports are critical for improving AEMFC performance. This technology utilizes electrodes prepared with novel hybrid catalysts containing metal chelate compounds and nano-metallic particles with or without carbon or oxide-supports. Doping metal chelate compounds (such as transition metal phthalocyanines) with optimal adsorption characteristics toward $0H^-/H_20/O_2$ or $H_2$ species onto the metallic catalysts are critical for achieving maximal mass transports in the electrodes and improving AEMFC performance. These novel electrode designs use hybrid catalysts for oxygen reduction reactions and fuel (e.g. hydrogen, hydrazine, alcohol or glucose) oxidation reactions in AEMFCs or AFCs, or oxygen reduction reactions in metallic-air batteries.

Markets & Applications

Alkaline fuel cells (AFC’s) are one of the oldest types of fuel cell, operating between ambient temperature and 90C. AFC’s are the cheapest fuel cell to manufacture due to the wide variety of catalysts that can be used. AFC’s are currently being used by NASA’s Space shuttle Fleet and are being developed for wide scale use in portable and backup power supplies (<20kW). Stationary and transport applications may be available with further optimization of the technology in the future.

Competitive Advantage/Value Propositions

Alkaline fuel cells have favorable electrode reaction kinetics due to alkaline conditions, allowing for inexpensive, non-noble metal catalysts to be used for the fuel electrode. Corrosion problems are also substantially reduced in an alkaline environment. In addition, methanol can be used as a fuel in AFC’s, eliminating troublesome storage and transportation requirements of pure hydrogen gas. This AFC technology could potentially replace the need for a platinum catalyst at the oxygen reduction reaction electrode using a less expensive non-Pt material that offers similar stability and operation potential to current platinum based catalysts. Rotating disk electrode and polarization measurements suggest that this combination achieves a similar power density to platinum catalysts (6.25% less power density than Pt/C). Platinum is currently 50 times more expensive than Silver per kg.
NOVEL HYBRID CATALYSTS CONTAINING METAL CHELATE COMPOUNDS WITH TUNABLE ELECTROCHEMICAL ACTIVITY, cont.

Researcher Biography

Rongrong Chen, Ph.D
Dr. Chen received her B.S. in Physical Chemistry from Xiamen University in 1983 and her Ph.D. in Electrochemistry from Case Western Reserve University in 1993. Her research interests include fuel cells and advanced battery systems, multi-scale modeling simulation of materials, surface coating and characterizations, and nano-materials for chemical or biomedical devices.

Development Plans/Needs

1. The group is working towards proving the durability of the catalysts for the targeted applications, which will need further research funding.

2. An extensive market analysis is needed for additional applications of the technology, which will be conducted in next few months if new funding is available.

3. Dr. Chen is looking for potential SBIR opportunities to test the stability and material performance in long duration cycle testing. The technology has been designed around anion-exchange-membrane fuel cell applications, and may not be suitable for conventional liquid alkaline fuel cells.