Two-Dimensional Nanoframe High Activity and Stability Oxygen Reduction Catalysts For Fuel Cells

Discovery and development of proton-exchange membrane fuel cell oxygen reduction catalysts with high activity and stability

Contact
Reddy Venumbaka, P.hD.
Director, Technology Transfer and Contracts
Phone: 512-245-2672
reddy@txstate.edu

Lead Inventor
Christopher Rhodes, Ph.D.

Field
Catalysis/Material Science
Energy

Technology
Catalyst for Fuel Cells

Key Features

- The catalyst is ~8 times more active than Pt/C
- The catalyst exhibits enhanced stability at elevated voltage cycling (>1.0 V_{RHE})
- The catalyst is carbon-free providing higher durability
- Synthesis is scalable and does not require severe conditions
- The catalysts reduce the concentration of precious metals.

Stage of Development
Proof-of-concept achieved

Status
Seeking commercial development and/or licensing partner

Patent Status
US Application Filed
(October 2017)

Background

Oxygen reduction reaction (ORR) electrocatalysts with improved activity and stability are key components of proton exchange membrane fuel cells (PEMFCs) being developed for transportation as well as stationary power and portable equipment applications. Rhodes et al., at Texas State University have demonstrated a unique unsupported (carbon-free) Pi-Ni alloy ORR catalyst nanoarchitecture is obtained from controlled treatment of a Pt-decorated nanosheets.

Technology & Competitive Advantage

The new ORR electrocatalysts have higher activity and better durability than commercial carbon-supported Pt and other Pt-metal alloy catalysts. While high activity catalysts have been developed, catalysts that show improved stability within the important elevated voltage region encountered during start-up/shut down cycles remain a key challenge. Typical carbon-supported ORR catalysts show low stability when cycled at elevated potentials (above 1.0 V_{RHE}). The ORR catalysts developed by Texas State researchers have shown the highest combined specific activity and stability at elevated voltages reported to date (Figure 1). The catalyst specific activity is ~8 times higher than conventional Pt/C, and exhibits significantly improved durability compared to current catalysts within the important elevated voltages encountered during start-up/shut down cycles. The catalyst synthesis is highly scalable. The invention is comprised of a two-dimensional platinum-transition metal nanoarchitecture that functions as a carbon-free ORR electrode. The unique 2D nanoarchitecture consists of through-connected porosity that allows molecular accessibility without the inclusion of carbon. The framework promotes higher activity of the Pt via the formation of alloy phases formed during a proprietary thermal treatment. This increases the Pt activity and reduces the loading of precious metals required.

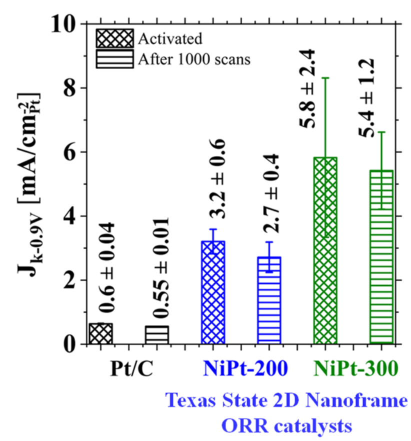

Figure 1. Enhanced activity and stability of Texas State 2D nanoframe ORR catalysts compared with Pt/C.

Opportunity

The global fuel cell market size was more than 180,010 units for 2015 and is predicted to register more than 24.1% of CAGR by end of 2024. Major applications are currently in stationary power generation and portable devices. A growing transportation market is expected to develop. The PEMFC technologies are the largest segment of the market. Lower cost and more stable catalysts are a key enabler of market growth.