The HKUST Energy Institute 香港科大能源研究院

DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING 化學及生物工程學系

中國科學院長春應用化學研究所-香港科技大學 CIAC-HKUST

氫能聯合實驗室 Joint Laboratory for Hydrogen Energy

Joint Seminar

Super Stable and Highly Active Pt and Pt Alloy Catalysts over Nanostructured Single-Pt-Atomic-Site for PEMFCs

Prof. Jian Xie

Purdue University, West Lafayette

Indiana University – Purdue University Indianapolis (Indianapolis, Indiana)

Date 22 May 2024 (Wednesday)
Time 4 – 5 pm
Venue Chen Kuan Cheng Forum (LT-H), (Lifts 27-28), HKUST (Location)

Abstract

Polymer electrolyte membrane fuel cells (PEMFCs) for heavy-duty vehicle (HDV) applications require the membrane electrode assemblies (MEAs) with high durability and efficiency, which directly associate with the activity and stability of the cathode catalysts for the oxygen reduction reaction (ORR). We are developing the innovative single-Pt-atomic-site Pt-N-C supports and the new class of platinum group metal (PGM) catalysts over such supports to achieve the enhanced activity and super strong stability, in combination with an ingeniously designed ionomer/catalyst interface into an ideal nanostructured MEA for HDV applications. For traditional PGM catalyst with non- or functionalized supports (carbon black, nanotube, graphene, metal oxides etc.), severe particle surface migration due to the physically weak/non interaction between PGM nanoparticles (NPs) is mainly responsible for the catalyst degradation in PEMFC operation. To overcome this nanoparticle migration, we developed the single Pt atomic sited Pt-N-C structured supports which uniformly distributes on and embeds on the single Pt atoms on the surface of carbon support at a very low Pt content (up to 1 wt.%Pt) but with extremely high site density, which enables the establishment of the strong Pt-Pt bonds between Pt atoms in the Pt NPs and the single Pt sites on the support surface after the catalyst synthesized. Such catalysts show superior stability and activity,1.07 A/cm^2 after 240,000 accelerated stress test (AST) cycles, which successfully exceeds the DOE 2025 targets, 1.07 A/cm^2 at 0.7V, 150k AST cycles, with 1.6X performance of targets.

About the Speaker

Dr. Xie is a professor at the School of Mechanical Engineering, School of Materials Engineering, Purdue University, and Department of Mechanical and Energy Engineering at the Purdue School of Engineering and Technology, IUPUI. He has published more than 80 journal papers including *Nature Energy*, *Nature Catalysis* and *Nature Communications*, and 2 book chapters, has 21 patents (10 issued). His research focuses on catalysis/electrocatalysis, energy conversion (i.e. fuel cells), energy storage (i.e. advanced batteries), nanomaterials, clear energy (i.e. electrolyzers etc.). He serves as a panelist for US National Science Foundation, Advanced Research Project Agency-Energy (ARPAE), Fuel Cell Technology Office, US Department of Energy Office of Technology Transfer, and the Canadian National Science Foundation. Before joining academia, he conducted research at Battelle Memorial Institute (fuel cells, Li-ion batteries, and artificial lungs), Cabot Corp (catalysts for fuel cells), Los Alamos National Laboratory (membrane electrolytes, catalysts, membrane electrode assembly, and durability of fuel cells). He developed electric propulsion systems for Electric Vehicles (EVs) and Hybrid EVs at General Motors Advanced Technology Vehicle Center. Dr. Xie received his PhD in chemistry from Miami University in 1999 and a BS in chemical engineering (emphasis on electrochemical engineering) from Tianjin University, China in 1982.

All are Welcome