Improved Low-Pt Loading Electrode Performance and Durability Through Catalyst Layer Design and Application

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The University of Connecticut is working to develop proton exchange fuel cells (PEMFC) that satisfy both Department of Energy, DOE, 2020 electrocatalyst and membrane electrode assembly, MEA, performance and durability targets using a system of low-PGM-content electrocatalysts deposited on corrosion-resistant carbon supports, applied onto ultra-thin membranes, to ensure applicability in high power density, self-humidifying automotive fuel cell stacks.

We devoted specific attention to achieving high-performance low-Pt electrode structure, total loading of 0.15 mg/cm^2 by developing gradient cathode structures, prepared using reactive spray deposition technology (RSDT), which will be optimized for different carbon supports and ultra-thin membranes. We mitigated the impact of low-Pt loading on electrocatalyst durability in an electrode by studying and understanding ionomer-support-catalyst interactions, and electrode microstructure evolution at the triple-phase boundary upon exposure to automotive drive cycles (or its AST equivalents). The various interactions between electrode constituents are influenced by the manner in which the electrode is applied, which has a significant impact on the final 3-dimensional structure. The larger Pt particles of 5 nm toward the membrane layer and a higher Pt to C ratio insures longer stability. The RSDT process combines catalyst synthesis, support impregnation, and film formation into a *single step* and gradient structure optimization is a function of the components introduced.

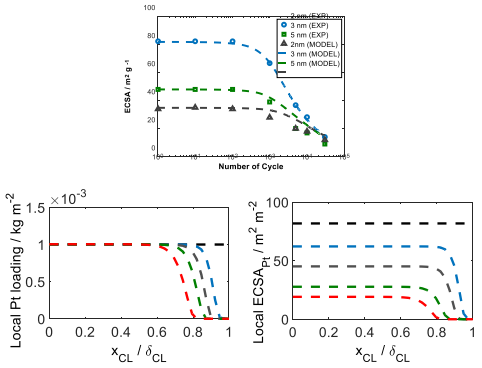


Fig.1 Results of the macro model simulations: (a) Comparison of the evolution of ECSA during AST from experiments and simulations; (b) Simulated local concentration of metallic Pt at different time steps for the sample with 2 nm particle size; (c) Simulated local ECSA in the catalyst layer for the sample with 2 nm particle size.

Recent Publications

1. Yu H (2017) Strategies to mitigate Pt dissolution in low Pt loading proton exchange membrane fuel cell: I. A gradient Pt particle size design, Electrochimica Acta, 247: 1155-1168.
2. Roller J (2017) A study on the effect of selected process parameters in a jet-diffusion flame for Pt nanoparticle formation, Journal of Material Science 16: 9391-9402.
3. Yu H (2016) The influence of carbon support and platinum particle size on the degradation of cathode for low platinum-loading catalyst layer, ECS Transactions, 72: 41-55
4. Ayers K.E. (2016) Pathways to ultra-low platinum group metal catalyst loading in proton exchange membrane electrolyzers, Catalysis Today, 261: 121-132.
5. Roller J. A Study on Reactive Spray Deposition Technology Processing Parameters in the Context of Pt Nanoparticle Formation, Journal of Thermal Spray Technology, 24: 1529-1541.



Biography

Dr. Radenka Maric, Ph.D. is UConn's Vice President for Research where she oversees the University's $200M+ research enterprise at all campuses, including UConn Health. Prior to this role, Dr. Maric served as Executive Director for UConn's $132M Innovation Partnership Building, which has already leveraged more than $80M in industry and federal agency projects. She also led and continues to drive strategic efforts to build fundamental and applied research and technology commercialization capabilities in partnership with government, industry, and other academic leaders. Her research interests include fundamental understanding of the effect of structure, defects, and microstructure on transport and electrical properties of surfaces and interfaces.

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