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Hierarchical approach of mitigating carbon influence in nano-porous electro-catalyst with unique surface islands for efficient methanol resistive oxygen reduction

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Abstract

For the first time, we report a facile one pot aqueous method for support-free $Pd_{85}Pt_{15}$ nano-porous structures (NPoS) synthesis from PdMn nano-alloys at ambient conditions. A hierarchical approach was successfully employed through a simple "self-settlement" process with descending amounts of carbon to carbon-free electro-catalysts to improve catalyst utilization and avoid carbon degradation during operating conditions. $Pd_{85}Pt_{15}$ NPoS exhibits enhanced methanol resistive oxygen reduction reaction (ORR) activity owing to the presence of highly active and unique surface PdPt islands compared to HiSPEC Pt/C catalysts. Accelerated durability tests of the support-free PdPt NPoS show enhanced durability in harsh acidic environment (1.0 N H_2SO_4) compared to HiSPEC Pt/C and DOE 2017-2020 durability target. Preliminary direct methanol fuel cell studies using hierarchically derived $Pd_{85}Pt_{15}$ NPoS variants were performed at ultra-low Pt content. The effects of carbon content and catalyst layer thickness on fuel cell activities are well discussed.

Keywords: Nano-porous surface, surface-active Pd-Pt islands, methanol tolerant oxygen reduction reaction, direct methanol fuel cell, support-free ORR catalysts