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MnO_2-Carbon Nanotubes Catalyst for Enhanced Oxygen Reduction Reaction in Polymer Electrolyte Membrane Fuel Cell

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Abstract : Polymer electrolyte membrane fuel cell (PEMFC) is an electrochemical cell, which undergoes an oxygen reduction reaction to produce electrical energy. Platinum (Pt) metal has been used as a catalyst since its inception, but expensiveness is the major obstacle in the commercialization of fuel cells. Herein a non-precious group metal (NPGM) is employed instead of Pt to reduce the cost of PEMFCs. Manganese dioxide impregnated carbon nanotubes (MnO_2-CNTs composite) is a catalyst having excellent electrochemical properties and offers a better alternative to the Platinum-based PEMFC. The catalyst is synthesized by impregnating the transition metal on large surface carbonaceous CNTs by hydrothermal synthesis techniques. To enhance the catalytic activity and increase the volumetric current density, the sample was pyrolyzed at 800°C under a nitrogen atmosphere. During pyrolysis, the nitrogen was doped in the framework of CNTs. Then the material was treated with acid for removing the unreacted metals and adding oxygen functional group to the CNT framework. This process ameliorates the catalytic activity of the manganese-based catalyst. The catalyst has been characterized by scanning electron microscope (SEM), X-ray diffraction (XRD), and the catalyst activity has been examined by rotating disc electrode (RDE) experiment. The catalyst was strong enough to withstand an austere alkaline environment in experimental conditions and had a high electrocatalytic activity for oxygen reduction reaction (ORR). Linear Sweep Voltammetry (LSV) depicts an excellent current density of -4.0 mA/cm^2 and an overpotential of -0.3V vs. standard calomel electrode (SCE) in 0.1M KOH electrolyte. Rotating disk electrode (RDE) was conducted at 400, 800, 1200, and 1600 rpm. The catalyst exhibited a higher methanol tolerance and long term durability with respect to commercial Pt/C. The results for MnO_2-CNT show that the low-cost catalyst will supplant the expensive Pt/C catalyst in the fuel cell.

Keywords : carbon nanotubes, methanol fuel cell, oxygen reduction reaction, MnO_2-CNTs
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