Incorporation of Platinum and Gold Partially Reduced Graphene Oxide into Polymer Electrolyte Membrane Fuel Cells for Increased Output Power and Carbon Monoxide Tolerance

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Polymer Electrolyte Membrane Fuel Cells (PEMFCs) can potentially provide “green” energy but its platinum catalyst’s susceptibility to carbon monoxide (CO) poisoning reduces output power. High temperature oxidation of CO degrades the fuel cell polymer membrane. Nanoparticle catalysts tend to aggregate, decreasing their catalytic ability. This project hypothesized that incorporating gold and platinum nanoparticles onto partially reduced graphene oxide (Au/Pt-prGO) sheets would reduce both aggregation and the amount of precious metal needed, with prGO’s large surface area increasing the catalytic ability. Application of metalized-prGO onto the electrodes and Nafion membrane of a PEMFC could increase both CO tolerance and power output. A simple desktop synthesis at room temperature created aliquots of graphene oxide (GO) functionalized with platinum and/or gold nanoparticles. Partial reduction with NaBH4 maintained hydrophilic solubility. Raman Spectroscopy, SEM and HRTEM verified the chemical identity and structure of the materials and demonstrated that prGO is an intermediate between GO and reduced graphene oxide (rGO). Testing first in a PEM fuel cell with a pure H2 gas feed, all the test materials averaged an output power 137% that of the control. Test setups on the second round of experimentation, with a H2 gas feed containing 1000 ppm of CO, averaged an output power >200% of the poisoned control. The most effective sample yielded an output power ~250% that of the poisoned control. Each setup’s poisoned output power (P¬P) was compared to its highest possible output power (PM). The AuPt-prGO Electrode + Membrane setup displayed 100% resistance to all CO poisoning.