Size Optimization of Gold Nanoparticles Functionalized on PEMFC Interfaces to Increase Power Efficiency

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Proton Exchange Membrane Fuel Cells are efficient electrochemical energy conversion devices that use hydrogen and oxygen as fuel and produce water as exhaust. As a result, they are one of the cleanest energy sources. However, PEMFCs are particularly vulnerable to the carbon monoxide contaminant in hydrogen fuel, which competitively inhibits active sites of the platinum catalyst. This research focuses on maximizing the size of gold nanoparticles in PEMFCs to achieve on-site oxidation of carbon monoxide, preventing the fuel cell from deteriorating. Experimentation was performed using solutions with 0.85 and 0.43 molar ratios of thiol to gold to apply on the fuel cell membrane. Student developed the methodologies used to synthesize and coat Nafion 117 membranes and proposed assembly of the electrode components to form the Membrane Electrode Assembly (MEA). Building and testing the hydrogen fuel cell was performed by the mentor. Raw data was provided to student for analysis. Data showed a 27% increase in maximum power output in Au0.85 functionalized Nafion compared to the control, and a 6% increase in Au0.43 functionalized Nafion. An increase in power output was also observed across all operating currents of the fuel cell, showing that gold nanoparticles produce significant increases in cell efficiency especially at smaller sizes. TEM analysis of the Au0.85 batch shows a distribution of particle diameter with average size 3.37 ± 0.83nm and D50 3.32nm. The particles were also very monodispersed and homogenous, both crucial properties aimed to achieve.

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