Application of Electrospun Poly(acrylic acid)-Platinum/Carbon Catalyst Ink to Optimize Polymer Electrolyte Membrane Fuel Cell Performance

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With global consumption of fossil fuels at an all-time high, climate change has catalyzed one of the greatest sustainability challenges facing the world today. At the cutting-edge of material science research, hydrogen fuel cells, namely Polymer Electrolyte Membrane Fuel Cells (PEMFCs), provide an alternative source of clean energy through the oxidation-reduction reaction of hydrogen and oxygen gas. With applications ranging from hydrogen-powered space shuttles to gasless vehicles, PEMFCs promise to transform hydrogen energy from an early-stage innovation into an affordable reality. This study employs a novel electrospinning technique to enhance proton conductivity across the Polymer Electrolyte Membrane (PEM). By producing Three-Dimensional nanofiber structures, we aim to increase the surface area to volume ratio for redox catalysis and thus, optimize hydrogen fuel cell performance. To produce homogenous electrospun fibers, different polymers were tested until Poly(acrylic acid), dissolved in a 2 isopropanol : 1 water solvent, was chosen for its optimal viscosity. With a 12% Nafion-PAA base solution, fibers of consistent diameter (1 μm) were produced with Pt/C nanoparticles effectively attached, as proven by SEM imaging. The electrospun, commercial, and airsprayed electrodes were then tested in a single-stack hydrogen fuel cell in an open-air environment. Performance testing revealed that electrospun electrodes exhibited a 208% increase in maximum power output compared to the airsprayed control. By determining the precise combination of base polymer, Nafion, and Pt/C required to produce electrospun catalyst layers, this research sets the foundation for interdisciplinary research between traditionally-biological fiber formation and the optimization of chemical energy.

Awards Won:

Third Award of $1,000