The Utilization of Platinum Catalysts Deposited on Carbon Support Synthesized From Coffee Grounds in a Polymer Electrolyte Membrane Fuel Cell

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Hydrogen is a clean energy source with tremendous unrealized potential. When oxidated in a polymer electrolyte membrane fuel cell (PEMFC), it produces energy at a rapid rate, whilst only producing water as a byproduct. However, widespread use of PEMFCs is limited by the expensive components required, such as catalysts. As the properties of the catalyst material are largely determined by the support on which it is deposited, this project aims to synthesize an electrochemically active catalyst material, deposited onto carbon derived from coffee grounds. Carbon material was synthesized using zinc chloride activated pyrolysis and the Pt nanoparticles were deposited on coffee carbon (Pt(CGDC)) and commercial carbon (Pt(KB)) using two methods: using ethylene glycol or hydrogen as a reducing agent. Thermogravimetric analysis displayed that catalyst materials contained roughly 60 wt% of Pt, nitrogen sorption analysis showed that all studied materials were micro-mesoporous, X-ray diffraction revealed Pt crystallite size was found to be in correlation with catalytic properties and high-resolution scanning electron microscopy determined that the average Pt particle size is 4.7±2.5 nm. PEMFC measurements revealed that Pt(CGDC) produced comparable electrochemical activity to Pt(KB). Specifically, Pt(CGDC) produced a higher electrochemically active surface area of 64 m(Pt)^2/g(Pt), compared to Pt(KB) with a value of 51 m(Pt)^2/g(Pt). Despite that, both catalyst materials produced similar current densities at 670 mV of 0.68 A/cm^2 (Pt(CGDC)) and 0.70 A/cm^2 (Pt(KB)). In addition, both produced comparable maximum power density of 0.56 W/cm^2 and W/cm^2 respectively.