Abstract

The thesis entitled "*Synthesis and Electrocatalytic Activity of Pt and Pt-Pd Bimetallic Nanoparticles for Low Temperature Fuel Cell Applications*" describes the chemical and electrochemical synthesis of Pt and Pt-Pd bimetallic nanoparticles of different shapes and their electrocatalytic activity towards fuel cell reactions such as oxygen reduction, methanol and formic acid oxidation. Pt nanoparticles of branched, polyhedral and flowerlike shapes were synthesized and characterized by analytical techniques. Modified polyol method was employed to synthesize branched Pt nanoparticles of 10 (nPtB-10) and 15 nm (nPtB-15) and polyhedral Pt nanoparticles of 25 nm. The flowerlike Pt nanoparticles of 80 nm were synthesized directly over MCNTs in aqueous solution using H_2 gas as reducing agent. The nPtB-10 nanoparticle catalyzes the oxygen reduction reaction (ORR) at more positive potential and has high kinetic current density compared to other Pt nanoparticles. In the methanol oxidation reaction (MOR) the nPtB-15 nanoparticles have high resistance towards CO-like intermediates. Electrochemical impedance measurements for MOR show that the impedance behavior depends on the electrode potential. MCNT-supported Pt-Pd alloy nanoparticles of $Pt_{28}Pd_{72}$, $Pt_{46}Pd_{54}$ and $Pt_{64}Pd_{36}$ composition were synthesized by polyol method and their electrocatalytic performance towards ORR was evaluated. The $Pt_{46}Pd_{54}$ nanoparticles have high kinetic current density, durability and methanol tolerance during ORR. The Pt-on-Pd bimetallic nanoparticles of $Pt_{21}Pd_{79,}$ $Pt_{52}Pd_{48,}$ and $Pt_{64}Pd_{36}$ compositions were synthesized using ascorbic acid as a reducing agent. The $Pt_{64}Pd_{36}$ composition has the highest specific activity 342 $\mu A/cm^2$ at 0.9 V and it has excellent durability compared to other compositions. The bimetallic nanoparticles of flowerlike morphology with Pt_4Pd_{96}, Pt_7Pd_{93} and $Pt_{47}Pd_{53}$ compositions were synthesized by electrochemical co-deposition. The Pt-Pd nanoparticles of ultralow Pt content have superior electrocatalytic activity towards electrooxidation of formic acid. The $Pt_{47}Pd_{53}$ nanoparticles favor the dehydration pathway involving the formation of CO at the potential of 0.88 V whereas the Pt_4Pd_{96} nanoparticles favor via CO-free pathway.

Keywords: Electrocatalysis; Pt-Pd nanostructure; Oxygen reduction; Methanol and formic acid oxidation.