Synthesis and Characterization of Ni Modified Pd based Electrocatalysts

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Abstract

Direct formic acid fuel cells (DFAFCs), which are type of proton exchange membrane fuel cells, use formic acid as fuel, which has the advantages of non-toxic, non-flammable, and liquid at normal temperature and pressure. In order to prevent the anodic palladium catalyst from being poisoned by CO during the electrocatalysis process, the transition metals or transition metal oxides can be added to increase the catalyst activity, durability, and resistance to CO poisoning.

In this study, nickel or nickel oxide modified palladium-based catalysts were synthesized on acid-oxidized multi-wall carbon nanotubes as carrier. Then Pd was reduced on the carrier by X-ray photosynthesis to form Pd/ NiO/AO-MWCNTs and Pd/Ni/AO-MWCNTs by 01A beamline in NSRRC. Raman, XRD, FT-IR, SEM, ICP-OES were used to determine the structure, composition, surface morphology and metal element content of the products. The cyclic voltammetry was used to evaluate the electrochemically active surface area and formic acid catalytic properties of the product.

The results showed that XRD confirmed that Pd/NiO/AO-MWCNTs and Pd/Ni/AO-MWCNTs had separate phases, while Pd-Ni/AO-MWCNTs formed a solid solution phase. SEM analysis results showed that the addition of Ni and NiO helped reducing the particle size of Pd. The catalysts with Pd-Ni solid solution had a more stable current density than pure Pd catalyst. Whether Ni and Pd form a solid solution phase or not, the Pd catalyst had a lower voltage for catalyzing formic acid. With the addition of nickel oxide, the stability of current density and voltage for catalyzing formic acid can be improved. Among all the prepared palladium-based catalysts, Pd / [NiO / AO-MWCNTs-Ar 300^{o}C] is the best anodic catalyst for DFAFC.

Keywords: DFAFC, electrocatalyst, carbon nanotube, palladium, nickel, nickel oxide.