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A Fast Method for Graphene-Supported Pd-Co Nanostructures as Catalyst toward Ethanol Oxidation in Alkaline Media

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Abstract : Nowadays, fuel cells as a promising alternative for power source have been widely studied owing to their security, high energy density, low operation temperatures, renewable capability and low environmental pollutant emission. The nanoparticles of core-shell type could be widely described in a combination of a shell (outer layer material) and a core (inner material), and their characteristics are greatly conditional on dimensions and composition of the core and shell. In addition, the change in the constituting materials or the ratio of core to the shell can create their special noble characteristics. In this study, a fast technique for the fabrication of a Pd-Co/G/GCE modified electrode is offered. Thermal decomposition reaction of cobalt (II) formate salt over the surface of graphene/glassy carbon electrode (G/GCE) is utilized for the synthesis of Co nanoparticles. The nanoparticles of Pd-Co decorated on the graphene are created based on the following method: (1) Thermal decomposition reaction of cobalt (II) formate salt and (2) the galvanic replacement process Co by Pd2+. The physical and electrochemical performances of the as-prepared Pd-Co/G electrocatalyst are studied by Field Emission Scanning Electron Microscopy (FESEM), Energy Dispersive X-ray Spectroscopy (EDS), Cyclic Voltammetry (CV), and Chronoamperometry (CHA). Galvanic replacement method is utilized as a facile and spontaneous approach for growth of Pd nanostructures. The Pd-Co/G is used as an anode catalyst for ethanol oxidation in alkaline media. The Pd-Co/G not only delivered much higher current density (262.3 mAcm-2) compared to the Pd/C (32.1 mAcm-2) catalyst, but also demonstrated a negative shift of the onset oxidation potential (-0.480 vs -0.460 mV) in the forward sweep. Moreover, the novel Pd-Co/G electrocatalyst represents large electrochemically active surface area (ECSA), lower apparent activation energy (Ea), higher levels of durability and poisoning tolerance compared to the Pd/C catalyst. The paper demonstrates that the catalytic activity and stability of Pd-Co/G electrocatalyst are higher than those of the Pd/C electrocatalyst toward ethanol oxidation in alkaline media.

Keywords : thermal decomposition, nanostructures, galvanic replacement, electrocatalyst, ethanol oxidation, alkaline media
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