Carbon electrodes-supported Pd nanocatalysts obtained through electroless metal deposition

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Palladium and Pd-based materials are continuously studied as catalysts for the oxidation of small organic molecules such as methanol, ethanol, formic acid and glycerol, all considered as anodic fuels. The constant effort to find the best performing and endurable electrocatalysts goes into different directions and includes involvement of various metal deposition approaches as well as use of a number of carrying supports (e.g., various carbon-based materials, etc.).

In the present studies, palladium nanocatalysts were obtained by electroless metal deposition on five different types of carbon screen printed electrodes (SPEs) and on poly(3,4-ethylenedioxythiophene) (PEDOT)-coated graphite electrodes. The carbon SPEs consisted of carbon, mesoporous carbon (MC), cabon nanotubes (CNT)-, single walled nanotubes (SWCNT)-, and carbon nanofibers (CNF)- coated carbon. AFM studies were used to evaluate the root mean square roughness and the true surface area (TSA) of the carbon electrodes. After accounting for the TSA, the capacitance of the carbon-based SPEs was found to be rather high thus implying a significant effect of nanoroughness and/or of a large internal porous structure especially for CNF and MC SPEs.

Pd electroless deposition was found to occur at all studied carbon-based electrodes after reductive pre-treatment in supporting electrolyte, without using a solute chemical reductant in the metal plating solution. The amount and type of the Pd deposit depended on the structure of the carbon-based electrodes with nanostructured carbon coatings (i.e., CNT, SWCNT, or CNF) providing higher amounts of deposited Pd and smaller size of the obtained metal particles. In the case of PEDOT-coated graphite the type of the Pd deposit was found to depend significantly on the dopant used for the electrochemical synthesis of PEDOT.

The PEDOT-supported Pd catalysts were investigated for their electrocatalytic response to formic acid oxidation. The surface roughness of the PEDOT-coated electrodes was compared before and after exposure to formic acid. It was established that the dopant used to obtain the PEDOT layers has a major role for the stability of the composite electrodes upon electrochemical treatment in the presence of formic acid.

References

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