Hydrothermal deposition of metal nanoparticles onto carbon microspheres as catalysts for H_2O_2 reduction

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A simple and facile hydrothermal methodology for preparation of carbon microspheres (CMS) supported with silver or platinum nanoparticles is presented. CMS are probed as electrode material in electrochemical reduction reaction of hydrogen peroxide in model solution.

Transmission electron microscopy (TEM) revealed that silver and platinum are immobilized on the surface of the carbon microspheres in a form of nanoparticles. In addition, scanning electron microscopy showed coexistence of smooth surface spherical-shaped carbon microspheres together with grape shaped clusters.

Cyclic and square-wave voltammetry used to study electrocatalytic properties of carbon microspheres by the carbon paste technique evidenced pronounced electron charge-transfer ability of the modified electrodes. Ag-dopped CMS electrode, followed by Pt-doped and native CMS-graphite electrodes, manifested improved electrode kinetics in comparison to bare graphite electrode at the same conditions. Although the electrode mechanism is relatively complex, an attempt is done to study the electrode reaction in the light of a simple irreversible electrode reaction. A mathematical model is developed and theoretical voltammograms are presented in the form of dimensionless current function Ψ. The simulations show that the peak potential of a simple irreversible reaction is unaffected by the concentration. The peak potential is becoming less negative when CPE is modified with carbon spheres, the effect being even more pronounced in the case of metal-doped spheres. The frequency of potential pulses and SW amplitude are proven to be the most important parameters in squarewave voltammetry. The results based on the amplitude variation imply that the electrode reaction has the highest rate at the Ag-doped electrode. Conclusively, carbon microspheres modified with a doping amount of Ag or Pt nanoparticles are promising electrode modifiers for studying and detection of hydrogen peroxide.