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Ordered polyaniline nanotubes modified by carbon nano-onions - a conductive and capacitive nanocomposite as a biocompatible support for horseradish peroxidase in hydrogen peroxide detection

Piotr Olejnik and **Marta Płońska-Brzezińska**
University of Bialystok, Poland

The glassy carbon (GC) electrode surface has been covered by horseradish peroxidase (HRP) attached to the ordered polyaniline nanotube / carbon nanoonion (PANINT / CNOs) nanocomposite. The presented biosensing system exhibits capacitive properties and is sensitive to hydrogen peroxide. The synthesis of PANINT was accomplished by the template method using polycarbonate (PC) membranes one-sidedly sputtered by a thin, uniform gold layer. The conductive polymer nanostructures perpenidicularly attached to the gold film were externally modified by CNOsox. For this purpose the pristine CNOs were treated by nitric acid and the newly formed surface oxygen groups were activated in the presence of carbodiimides EDC/NHS mixture. Obtained nanocomposite film was immobilized on the GC electrode surface. The PANINT / CNOs nanocomposite was subsequently used for HRP anchoring. SEM analysis indicate an uniform and ordered structure of conductive polymer nanotubes immobilized on the thin gold film covered by multi-shell fullerenes. PANINT coated by CNOs increase the working surface of the electrode. The infrared and Raman spectroscopy were used to investigate the composition of PANNT /CNOs and indicate the presence of the enzyme molecules. The obtained nanocomposite calls to mind a brush-like architecture and exhibits specific capacitance 946 Fg-1 at a scan rate 1 mVs-1. The PANINT / CNOs material is also biocompatible for HRP which as immobilized on the nanocomposite surface directly catalyzes electroreduction of the hydrogen peroxide. The adsorbed enzyme preserves and reveals high bioactivity. The direct, mediatorless electrocatalytic current due to the hydrogen peroxide reduction was observed starting from -0.40 V versus Ag/AgCl at pH 7.4. Such potential value is close to the redox potential of the HRP active site. It is possible due to the high conductivity and a rough and well-developed specific surface area of the nanocomposite intermediary layer. The PANINT / CNOs nanocomposite was tested as a high potential and long-term stable electrode used in easy to miniaturize high-performance supercapacitor and mediatorless biosensor device sensitive to hydrogen peroxide.

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