Fabrication of composite nanostructures for impedance biosensors using anodic aluminum oxide templates and carbon nanotubes

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Abstract: A hybrid material consisting of an array of vertically ordered carbon nanotubes (CNTs) in porous anodic alumina was fabricated directly on oxidized Si substrates. Individual CNTs with vertical orientation were grown using the catalyst Ni nanoparticles (NPs) embedded in the pore walls of a thin template based on porous anodic alumina with a pore diameter of 40 ± 5 nm. The initial film was a two-layer Ti-Al structure on a Si/SiO_2 substrate. A vertically oriented porous structure was formed by anodizing the Al layer. Electrochemical deposition was used to form the catalyst Ni-NPs with dimensions of 30 ± 5 nm. CNTs were synthesized by high-temperature chemical vapor deposition. Scanning and transmission electron microscopy, Raman spectroscopy, and X-ray diffraction were used to analyze the surface morphology and microstructure of the composite nanostructures. The CNT length was (0.6–1.5) μm, and the CNT spacing was 110 ± 10 nm. It is expected that the resulting structure will serve as a basis for the development of CNT-based electrodes for electrochemical impedance biosensors. Electrochemical impedance spectroscopy was used for the electrochemical characterization of the fabricated CNT-based electrodes. The results showed that the CNT-based electrodes are characterized by improved electron transfer kinetics.

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