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Synthesis of Carbon Nanotubes from Coconut Oil and Fabrication of a Non Enzymatic Cholesterol Biosensor

Authors : Mitali Saha, Soma Das

Abstract : The fabrication of nanoscale materials for use in chemical sensing, biosensing and biological analyses has proven a promising avenue in the last few years. Cholesterol has aroused considerable interest in recent years on account of its being an important parameter in clinical diagnosis. There is a strong positive correlation between high serum cholesterol level and arteriosclerosis, hypertension, and myocardial infarction. Enzyme-based electrochemical biosensors have shown high selectivity and excellent sensitivity, but the enzyme is easily denatured during its immobilization procedure and its activity is also affected by temperature, pH, and toxic chemicals. Besides, the reproducibility of enzyme-based sensors is not very good which further restrict the application of cholesterol biosensor. It has been demonstrated that carbon nanotubes could promote electron transfer with various redox active proteins, ranging from cytochrome c to glucose oxidase with a deeply embedded redox center. In continuation of our earlier work on the synthesis and applications of carbon and metal based nanoparticles, we have reported here the synthesis of carbon nanotubes (CCNT) by burning coconut oil under insufficient flow of air using an oil lamp. The soot was collected from the top portion of the flame, where the temperature was around 6500C which was purified, functionalized and then characterized by SEM, p-XRD and Raman spectroscopy. The SEM micrographs showed the formation of tubular structure of CCNT having diameter below 100 nm. The XRD pattern indicated the presence of two predominant peaks at 25.20 and 43.80, which corresponded to (002) and (100) planes of CCNT respectively. The Raman spectrum (514 nm excitation) showed the presence of 1600 cm-1 (G-band) related to the vibration of sp2-bonded carbon and at 1350 cm-1 (D-band) responsible for the vibrations of sp3-bonded carbon. A nonenzymatic cholesterol biosensor was then fabricated on an insulating Teflon material containing three silver wires at the surface, covered by CCNT, obtained from coconut oil. Here, CCNTs worked as working as well as counter electrodes whereas reference electrode and electric contacts were made of silver. The dimensions of the electrode was 3.5 cm×1.0 cm×0.5 cm (length× width × height) and it is ideal for working with 50 µL volume like the standard screen printed electrodes. The voltammetric behavior of cholesterol at CCNT electrode was investigated by cyclic voltammeter and differential pulse voltammeter using 0.001 M H2SO4 as electrolyte. The influence of the experimental parameters on the peak currents of cholesterol like pH, accumulation time, and scan rates were optimized. Under optimum conditions, the peak current was found to be linear in the cholesterol concentration range from 1 µM to 50 µM with a sensitivity of ~15.31 µAµM−1cm−2 with lower detection limit of 0.017 µM and response time of about 6s. The long-term storage stability of the sensor was tested for 30 days and the current response was found to be ~85% of its initial response after 30 days.

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