Amperometric (bio)sensors based on carbon nanotubes

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Carbon nanotubes CNTs are attractive electrode materials due to their good electrical conductivity and mechanical strength, as well as being relatively chemically inert in most electrolyte solutions, where they still retain a high surface activity and a wide operational potential window. However, the proper construction and orientation of the carbon nanotube electrode is critical for its electrochemical properties; high density of open ends (similar to a graphite edge-plane electrode) can give fast electron transfer response but they only constitute a very small portion of the CNT surface exposed to the solution [1]. Side-walls and amorphous carbon-covered surface dominate on the overall surface area causing slower electron transfer kinetics. Moreover and from the point of view of the amperometric biosensing, the establishment of a fast electron transfer between the active site of a redox biomolecule and the electrochemical transducer is one of the topics that has taken considerable attention in order to design biosensors with progressing sensitive characteristics [2,3].

Accordingly, our purpose is to highlight the transducer and biosensor performance of different electrode systems and configurations based on carbon nanotubes and compare with graphite composites and highly oriented pyrolytic graphite. Specifically, the (bio)sensor behavior of the different carbon configurations functionalized with redox proteins (catalase and myoglobin) will be evaluated. Such proteins exhibit high sensitivity to oxygen and peroxide and are capable to catalyze the reduction of such species, which hold promise as oxygen and peroxide sensors [4]. Figure 1 shows a scheme of the different carbon systems that have been evaluated together with their respective images taken by Scanning Electron Microscopy (SEM). Our results confirmed that carbon nanotube electrodes constitute optimal environments for the direct electron transfer of such redox proteins. Additionally, we found that electrodes based on vertically aligned carbon nanotubes provide the highest electron transfer kinetics to the oxygen or peroxide reduction, the fastest sensor response and the highest signal/noise relation which has allowed the detection of very low analyte concentrations.

References:

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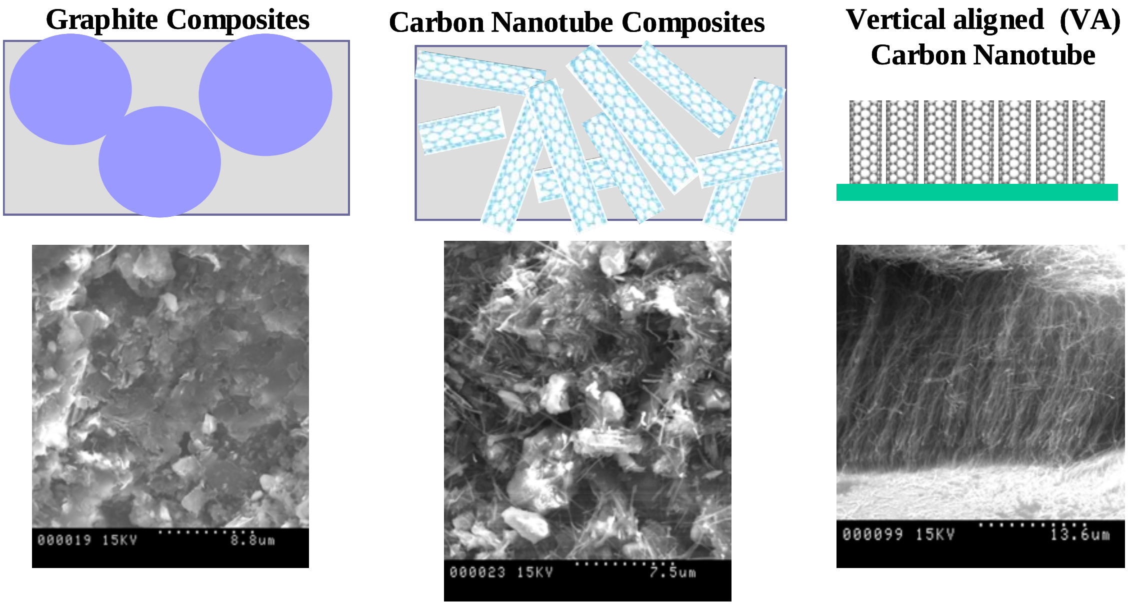

Figure 1. Scheme of the different carbon electrodes under study together with their respective SEM images.