

## THE BIOCOMPATIBILITY MICROORGANISMS-CARBON NANOSTRUCTURES FOR APPLICATIONS IN MICROBIAL FUEL CELLS

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In the broadest sense, biofuel cells would be defined as devices capable of directly transforming chemical to electrical energy via electrochemical reactions involving biochemical pathways. Biocatalysts, either protein, enzyme or whole organism, can also offer cost advantages over metallic catalysts, although this is not likely to be the case until the consumption of the enzyme is sufficient to merit large scale production. For long time, biofuel cells have been under research eye either as a curiosity but have recently reborn due to a series of bizarre applications already devised for future decades. Their study will enlarge our knowledge of the electrochemistry of the human body - where micro and nano microbial fuel cells (MFCs) can work in a cooperative way. A microbial fuel cell mimics a biological system which can be viable for sustained time. When incorporated into a MFC design, a colony of microorganisms nicely solves the hydrogen supply problem. Current efforts to improve the efficiency of such fuel cells are limited by the lack of knowledge about the microbial ecology of these systems: (i) to elucidate whether a bacterial community, either suspended or attached to an electrode, can evolve in a microbial fuel cell to bring about higher power output, and (ii) to identify species responsible for the electricity generation [1, 2]. Likewise, the need to have the highest conductivity and active surface area for carbon electrodes, combined with biocompatibility for working microorganisms in MFCs is one of biggest challenges for these devices. Thus, power generation depends of microorganisms and, biologically the potential losses can be resolved by the selection of adapted bacteria.

In this context, the study of the interaction between the carbon nanostructures and the biological systems represents a new and interesting research domain of bionanotechnology to the investigation of the process of growing for microorganisms. Fluorescent probe have been widely used to study the complexity of biological interactions in a variety of media. A new demand in bio-labeling is to be able to measure many biological indicators simultaneously in live cells. Quantum dots (QDs), by their unique light emitting properties are starting to attract considerable attention as novel luminescent probes [3, 4].

This work is focused on the evaluation of biocompatibility of *Escherichia coli* and *Staphylococcus aureus* with different species of nanocarbons in terms of their incorporation into a MFC anodic design. Thus, some types of bionanocomposites (BNC) were designed. The fluorescent QDs are used for labeling and rapid identification for colonies developed. The preliminary results entry by testing of nanocarbon with turbostratic structure synthesized by laser pyrolysis, in terms of biocompatibility with *Staphylococcus aureus* (Figure 1 shows optical microscopy for colonies developed on bionanocomposites with this type of nanocarbon), prove the prospective experiments with different types of CNTs from SWNT to MWNT with various morphologies and structures synthesized by the novolac pyrolysis with different adds of ferrocene.

Novolac (phenol-formaldehyde condensation resin) is one of the good graphene source giving pyrolysis structures with different aspects. The carbon nanotubes resulted in this systems have thick walls with large variation in the inner diameter, with relatively small defects, ropes and disordered carbon (Figure 2). Electrodes of carbon foam based on nanotubes resulted from polymer pyrolysis with ferrocene should be used with good results in MFC, being very well known that one of the major areas of CNT research is the field of

biosensors, biomedical materials and devices [5, 6]. Also, our CNTs were used before and after purification to investigate and the role of iron content in microorganisms' growing.

### References:

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### Figures:

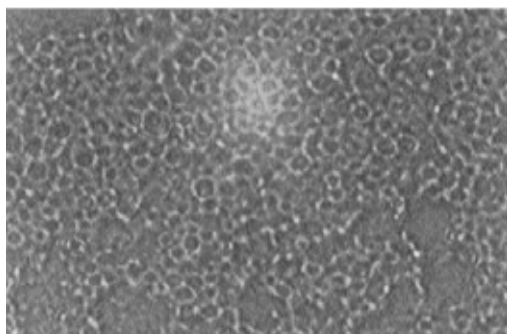


Figure 1. BNC with *Staphylococcus aureus*

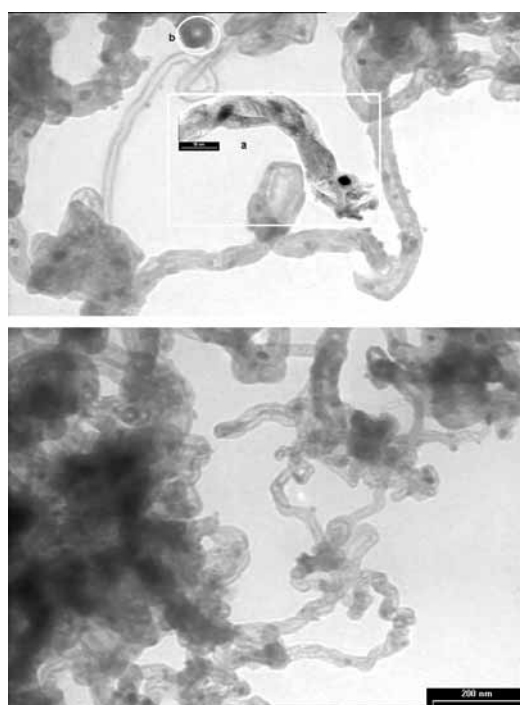


Figure 2. TEM image of a large amount of nanotubes and ropes random intercalated: in (a) is shown the rope morphology and in (b) a  $\text{Fe}_3\text{C}$  nanoparticle ending a nanotube.