Nanostructured Biochip Development for Stem Cell Monitoring

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Keywords: *Amperometric biosensors, carbon nanotubes, metabolites detection, cell culture monitoring*

Presentation:

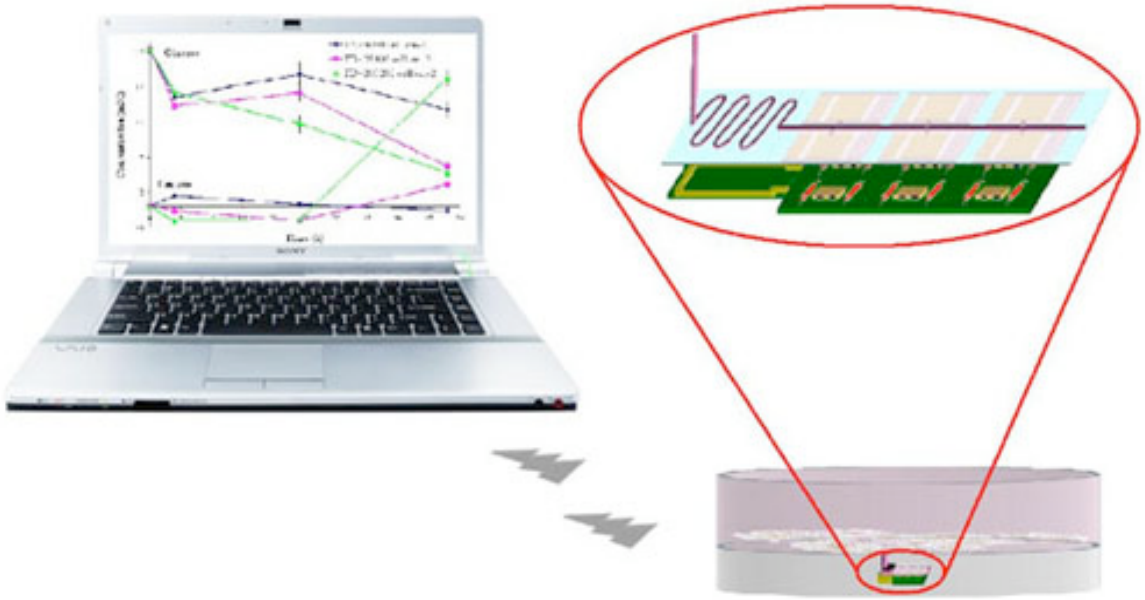
Glucose and lactate biosensors have been largely reported in literature for clinical purposes. On the other hand, metabolites biosensors applied to cell cultures have not been studied as much in the past. Glucose detection is interesting from the point-of-view to monitor its uptake by the cells, in order to deeply understand metabolic mechanisms. Another metabolite of interest is lactate, which is related to anaerobic metabolism due to hypoxia conditions.

One possible strategy to develop biosensors for the aforementioned compounds is to employ amperometric enzyme-based biosensors. For both the metabolites, electrodes have been structured with polymeric matrices, sol-gel, cross-linker, and mediators in order to optimize sensor response. Recently, nano-materials have been considered as possible electrical connectors to directly link the redox site to the electrode surface, because of the similar dimensions of nanoparticles and redox proteins. Various nano-materials have been studied in the last decade, including nanoparticles, nanowires and nanotubes. Carbon nanotubes have aroused increasing interest for their electrical and electrochemical properties with special focus on biosensors applications. Due to the small diameter of these nano-materials, from 1nm up to 100 nm, quantum-effects dominate, and therefore these nano-materials are efficiently coupled with proteins. Studies have demonstrated that CNTs promote the electron-transfer between the enzyme redox active site and the transducing electrode.

Goal:

The goal of the present research is the development of a chip for on-line detection of metabolic compounds in stem cell culture medium. The final device will appear as the system shown in figure, with the possibility to be integrated onto Petri dishes. The device will be able to autonomously take a sample of medium by the help of a microfluidic circuit, in order to measure metabolic compounds like glucose, lactate and glutamate by means of amperometric detection, and will transmit concentration values to a remote computer by RF. The system will be designed, realized and tested. The electrodes array will be the key element for metabolic compounds detection and it will be realized in clean room, nanostructured by using MWCNT, functionalized with the enzyme probe and tested onto target molecules. Oxidases will be used as the enzyme probe.

The motivation for this work is focused on two aspects: investigation of nanostructures such as carbon nanotubes to be applied on biosensing, in order to demonstrate the capability of nanomaterials to improve performances of biosensors; application of such biosensors to cell cultures, in particular to Pluripotent Embryonic Stem Cells (ESCs), where the knowledge is very poor, in order to better understand processes that happen when cells switch from the proliferation state to the differentiation state.



Biochip for the detection of metabolites like glucose, lactate and glutamate for cell culture monitoring

Publications:

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