TITLE: ELECTRO-CONDUCTING NANOARCHITECTURES TO ASSEMBLE (BIO)ELECTROCATALYTIC STRUCTURES AS BASIS FOR EFFICIENT AND STABLE BIOFUEL CELLS

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SCIENTIFIC DISCIPLINE: biomedical engineering

PROJECT DESCRIPTION: Wearable electronic devices have become essential for both personal and professional use. Several wearable devices are currently in use for medical applications, e.g. remote healthcare and monitoring physiological parameters as well as in smartwatches available in the market. Biofuel cells are promising as wearable biochemical power sources since they can operate using non-toxic chemicals and biocatalysts (enzymes, organelles or whole cells) to convert chemical energy into electricity using natural energy-rich components of body fluids such as human sweat (glucose, lactose, oxygen). **The project is aimed at developing biofuel cells with high power density and stability, which is needed for their usage to power supply wearable devices.** Enzymatic biofuel cells (EBFC) have high current and power densities and are interesting in terms of cost, as they enzymes instead of costly metallic catalysts. Improving enzymatic biofuel cells, i.e. increasing their durability and efficiency is a challenge for researchers. The main goal of research in this field is to improve the stability and efficiency of the biofuel cell and to adapt the composition and structure of the bioelectrodes to work as ready-to-use epidermal wearables. This project is aimed at improving the glucose-oxygen biofuel cell performance by adopting the main approaches: chemical functionalization of bioelectrodes and automated production method using direct printing by micro-dosing robot. In this project two main research hypotheses will be tested:
i) **Electrodeposition of gold nanostructures and carbon nanomaterials show synergistic effect on the electron transfer between enzymes and electrode surface.** The use of proposed structure has one more aspect: it leads to an increase in the actual electrode surface that should improve the parameters of the bio-cells.
ii) Grafting of **naphthoquinone-based redox polymer hydrogels** with enzymes on nanostructured bioanode can be a solution to the still-existing problem of mediator leaching from the electrode, simultaneously enhancing electron transfer between glucose dehydrogenase and electrode.
Moreover, this project is the first to propose the use of automated **direct-printing method** to print bioelectrodes on stretchable foil for potential usage in biofuel cells This method of preparation will allow to repeatedly print flexible bioelectrodes, that will not be deformed while in contact with skin, with high electrode surface.

REQUIREMENTS FOR CANDIDATES:
1. MSc in Chemical Technology, Chemistry, Biomedical Engineering, Nanotechnology or Materials Science; 2. Experience in surface functionalization and nanomaterials manipulation; 3. Experience in usage of electrochemical methods (CV, DPV) and spectrophotometric methods (FTIR, UV-vis); 4. Experience in analytical sciences: knowledge of techniques and good laboratory skills; 5. Basic knowledge of statistical methods; 6. Good reading and writing in English.