Project Outline

MSc in Nanoscience, Materials and Processes: Chemical Technology at the Frontier

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<th>Project title:</th>
<th>Harnessing nanotechnology to design wearable devices</th>
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| Supervisor contact details: | Dr Beatriz Prieto-Simón  
ICREA Research Professor  
Dept. Electronic engineering  
email: beatriz.prieto-simon@urv.cat  
www.beatrizprietosimon.com |
| Research area: | Nanotechnology, material science, bioengineering, chemistry |
| Key Words: | Porous semiconductor nanostructures; arrays of Electrochemical biosensors; biomarker detection |

Project Description

Introduction/Context:
Wearable technology has quickly evolved over the last decade. Among the various applications of this novel technology, special attention has focused on its clinical use to monitor at risk patients, to ensure prompt intervention at an earlier stage of a disease. More specifically, research efforts have been devoted to wearable devices integrated with biosensors, as a way to provide real-time data about the electrophysiological or biochemical status of a patient at point-of-care settings or in the clinic.

Biosensors for wearable applications can be embedded in electronic tattoos, patches, mouthguards, contact lenses, etc, to form conformal contact with biological tissue or bodily fluids. With the aim to develop wearable biosensors able to provide continuous, non-invasive measurements of key biomarkers in biofluids, such as sweat, tears, saliva and interstitial fluid, we will develop fit-for-purpose polymeric nanostructures. These nanostructures will be designed to perform as excellent electrochemical biosensing platforms retaining their function when contacting tissues and target biofluids.

Specifically, we will design, fabricate, modify and test polymeric nanostructures for sweat-based diagnostics. The design will focus on the main two challenges of these devices: (1) the potential adverse effects resulting from their operation at the interface with skin, such as potential fouling, long-term stability, and poor selectivity in front of common interferents in sweat and potential exogenous contaminants, and (2) the high sensitivity required, due to the fact that many analytes and disease biomarkers have been identified in sweat at much lower concentrations than in blood.

Successful devices should maximise the sensitivity, while preserving the biosensing layer from skin friction and contamination.

Main duties and responsibilities of the candidate:
- Read and review relevant literature;
- Fabrication of porous structures and their polymeric replica;
- Engineer the polymeric replica to produce an electrodic system to work as sensing patch;
- Functionalisation and modification of the sensing patch;
- Determine analyte concentrations in buffer and artificial sweat via electrochemical measurements using the developed sensing patch;
- Report writing (progress reports and final report);
- Attend meetings to discuss the progress of the project;
- Oral presentation.
**Methods & equipment:**
Electrochemical anodisation, polymeric replica moulding, conformal coating, chemical surface functionalisation, bioconjugations, surface characterisation, scanning electron microscopy, confocal microscopy, FTIR, voltammetry, electrochemical impedance spectroscopy.

**Training outcomes and objectives:**
We will explore the fabrication of nanostructured materials via polymeric replica moulding to produce wearable biosensors for sweat testing, and test their performance when analysing artificial sweat. Such performance will be assessed against the current challenges faced by this technology.

The candidate will be trained in the fabrication, functionalisation and characterisation of nanomaterials. S/he will acquire knowledge and expertise to perform design, develop and test wearable biosensors. S/he will acquire the required skills to use a range of electrochemical techniques.

**Additional or enhanced skills that will be acquired by the candidate:**
The candidate will acquire skills to develop wearable biosensors by strengthening her/his capacity of critical thinking, searching for alternatives, taking the initiative and making appropriate decisions.

S/he will learn to produce reports, papers and presentations of the highest quality.

S/he will get used to collaborate with other research groups working on multidisciplinary research areas, preparing presentations and participating in group discussions to assess the progress of the project and confirm or address the direction of future research.

S/he will be trained to maintain professional and ethical standards in the conduct of research according to the protocols established by the University Rovira i Virgili.

**Essential skills required by the candidate:**
- Knowledge and, ideally, some research experience in nanomaterials (synthesis and characterisation), electrochemistry, surface analysis.
- Demonstrated experience working as part of a small team and promoting a collaborative environment.
- The candidate has to be highly motivated and used to work collaboratively.

**References:**