

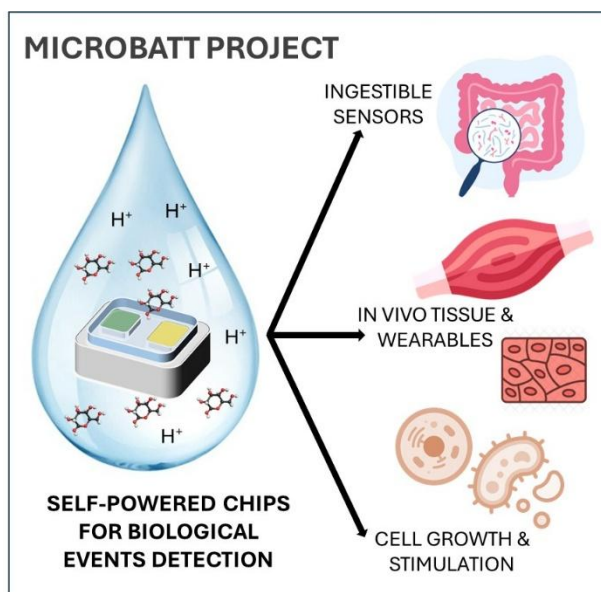
MICROBATT PROJECT

Instituto de Microelectrónica de Barcelona IMB-CNM (CSIC)

Microbatteries for autonomous detection of events in biological environments

JOB POSITION DESCRIPTION

The candidate will carry out the doctoral thesis within the framework of a project for the development of autonomous biosensing systems based on microbatteries integrated in CMOS technology. This battery-sensors device allow to avoiding the need of external



power sources and therefore will contribute to the miniaturization of current smart systems to sense and actuate at all body levels (e.g. dermal, in vivo and intracellular). The development of microbatteries integrated with CMOS circuits will be achieved for the first time and will facilitate the development of new autonomous devices for numerous applications, introducing intelligence and digitalization at small scale opening avenues for various applications in the field of wearable and ingestible sensors. Moreover, in a further step, the batteries will be passivated/functionalized with smart polymers that respond to changes of biological environmental conditions so

under the occurrence of a certain event, changes in the ionic conductivity of the material trigger the battery functioning. In such configuration, the batteries will become self-activated chemical sensors.

In this sense the candidate will carry out the following research activities:

- Development of microbatteries with silicon-based microfabrication processes. Cathode and anode materials optimization and characterization.
- Functionalization of the batteries with smart polymers and characterization of its response to biological environmental conditions (pH, glucose concentration, ion content)
- Integration of the microbatteries with basic CMOS-based electronic elements that manage the battery output signal.
- Push the limits of the technology to miniaturize the systems down to a few squared microns.
- Development and test of standalone proof-of-concept functional prototypes at laboratory level.

The candidate will be integrated in a highly interdisciplinary team of researchers that include: material science researchers, CMOS technologists, biologists and electrochemistry experts.

Candidate will be trained in clean room microfabrication process, physical, electrical and electrochemical characterization, and basic biological test in collaboration with the Cell Biological Department of the UAB.

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

The project aims to become the foundation of a new generation of miniaturized autonomous biosensing systems. It is a project with a high orientation towards technological development, as it targets the development of microbatteries in silicon substrates and their integration with CMOS electronic elements to show that it is possible to perform an autonomous and contactless sensing of ionic conductivity. Moreover, the functionalization of the battery core with smart polymers that respond to changes of the environment (such as pH, ion concentration or glucose content) will allow showing the viability of turning the batteries into tailored to the application self-powered biosensing entities, with potential applications in biological environments of difficult access (inside human body, inside tissue, inside cells).

The project PI – Neus Sabaté – is the head of the Self-Powered Engineered Devices Group who in the last years has pioneered the development of a printed battery and its operation as a self-powered conductivity sensor. She is also an expert in battery development with different chemistries and supporting materials – with a sustainability approach - and their characterization. She has been PI and coordinator of different regional, national and European proposals related to this field of research: Single-Use Paper Fuel cells (SUPERCELL) ERC Consolidator Grant (2015 – 2020), D2PATCH - Pegat Digital d'un sol ús per a la monitorització de la deshidratació - AGAUR – Programa PRODUCTE 2018 (2019 - 2020), ECOTAGS - Self-triggered ECObattery TAGS for instant and ubiquitous event detection - CERN – ATTRACT projects – (2019 – 2020), POWER-PATCH: Self-powered skin patch for cystic fibrosis diagnosis (ERC-Proof of Concept) (2019-2021), PRONTO: Self-powered conductometer for digitalization of rapid molecular diagnostics (ERC-Proof of Concept) (2023-2024).

More info at www.speedresearchgroup.com

ACADEMIC BACKGROUND / SKILLS

The fabrication of CMOS compatible microbatteries will require the optimization of the process in the clean room of the IMB-CNM (CSIC), in terms of cathode and anode materials of the microbattery, the electrochemical and electrical characterization and the compatibilization for polymer deposition for the functional batteries and their full characterization. Tests with biological samples will also be considered. For this purpose, we look for a candidate with a master's degree in bioengineering, chemistry, nanotechnology, electronic engineering, physics, willing to embrace a multidisciplinary project!