

## Development of ZnO nanonet based devices in view of interfacing with insect biomaterials for electronic nose applications

**Context:** Artificial odour detection is a complex action due to the large number of ligands, often molecularly related, and present in small quantities in an environment with frequently varying pressure and humidity. To achieve this objective, the Bac4Nose project, of which this internship is a part, relies on the combination of three interdisciplinary expertises. The first one relies on [IBS](#) expertise and is based on the use of insect olfactory receptors (iORs) in order to integrate them into the membrane of innovative nanobioparticles developed in the framework of Bac4Nose. The detection of the molecule targeted by the chosen iOR results in cationic enrichment of the core of the nanobioparticle which, by field effect, plays the role of a switch on the electronic device that it functionalizes. The second innovation relies on [LMGP](#) expertise and is based on the originality of the conducting channel of this electronic device. It is made up of a network of semiconductor nanowires that can be manipulated on a macroscopic scale and allows the manufacture of devices with a size ranging from 20 $\mu$ m to 1mm, with good sensitivity to surface events due to the nano components, good electrical performance and good reproducibility from one device to another. Finally, the third innovation relies on [TIMA](#) expertise and is based on the development, from the outset, of a bio-inspiration algorithm associated with a neural network that has the highest discrimination rate based on the real characteristics of the bio-signals obtained, compatible with nanonet devices and with minimal processing, power and integration costs. One of the promising applications of this technology is in medical applications for non-invasive in vitro diagnosis. Such devices are single-use, leading to an environmental impact. Thus, for the integration process, Bac4Nose will focus on laying the foundations for an economical, environmentally friendly technology, leading to efficient sensors, compatible with flexible substrates, and allowing large-scale use at low cost and low thermal budget.

### Position Instructions

In this context, this internship focus on developing the electronic devices that will interface with the nanobioparticles and transmit the odorant molecule detection information. ZnO nanonets, randomly oriented ZnO nanowire (NW) networks, form the core material of these devices, and are fully prepared in the laboratory, from the NW synthesis to the device fabrication and electrical characterization.

Several lines of development may be envisaged depending on the progress of the project at the start of the internship, and in particular on the delivery of our high-precision capillary printing equipment (Nazca by [HumminK](#)). This equipment will be the 2nd machine installed in France, and the 4th in the world, placing the work carried out during this internship at the cutting edge of technology.

As soon as the Nazca will be delivered, the aim of the internship will be to develop the manufacturing process for capillary-printed devices. In the absence of this equipment, the usual microelectronics technology processes will be used, and the main objective will be to obtain functional electronic devices in a wet environment.

The person recruited will synthesize ZnO nanowires by wet chemistry, shape the nanonets by filtration or capillary printing, then integrate them into functional devices (standard microelectronic processes or capillary printing) and test their electrical properties. Interfacing with nanobioparticles may be considered at the end of the internship in collaboration with Dr C. Moreau from IBS.

## Internship proposal (Master 2 or final internship) at the LMGP

---

Funding for a thesis has already been secured, and this opportunity will depend on the quality of the work carried out during internship, as well as the human and interpersonal skills of the student recruited.

### Qualifications

Applicants must have a Master 1 not older than 3 years at the application deadline in a related field of materials science, microelectronics technologies, and semiconductor physics, some knowledge in biology and or life cycle assessment are welcomed. Please address these skills directly in your application.

This position requires the ability to work in a team, excellent experimental skills and a taste for process development. Excellent academic results and fluency in written and spoken academic English will be appreciated.

### Application instructions

#### A complete application consists of:

**Cover page:** Short motivation of the applicant and connection with the position, including how this position serves future career goals. Include name and contact information of applicant (1 page max)

**CV:** Academic and professional background, detailing relevant experience, particularly research. Any publications (separate peer-reviewed, technical reports, and popular science or outreach). Any teaching experience. Include names and contact information for one or two academic or professional references who can speak to your professional and teamwork abilities. At least one should be a former or current research supervisor.

**Relevance for Application:** The applicant should include a clear description of how his or her scholarly background and expertise is applicable, and might add value, to the project set out above. The applicant should also outline the kind of methods and theories that he or she would propose to draw on when conducting the fieldwork.

Our team welcomes applicants with diverse backgrounds and experiences. We regard gender equality and diversity as strength and an asset.

Depending on the student's motivation, the internship may lead to a doctoral project.

**Laboratory:** LMGP collaboration with IBS and TIMA

**Supervisors:** Céline Ternon (0033 456 529 366) [celine.ternon@grenoble-inp.fr](mailto:celine.ternon@grenoble-inp.fr)  
<http://www.grenoble-inp.fr/annuaire/celine-ternon-703939.kjsp>

**Deadline for application:** 8<sup>th</sup> of December 2023, **Start internship:** from early February or March

**Documents to provide:** *CV, results M1 and M2 with ranking if possible, letters of recommendation*