



PhD thesis



Realization of sensors of volatile organic compounds for the early diagnosis of cancer pathologies

Scientific context and description of the project

With more than 14 million new cases each year and more than 8 million deaths worldwide¹, cancer is still the leading cause of death. To diagnose this disease and adapt the treatment to the patient, clinicians are led to use techniques that can be invasive, expensive, time-consuming and not always available in medical centers².

Another emerging approach to diagnosing or monitoring the course of the disease is based on the detection of volatile organic compounds (VOCs) emitted by the body. Serving as biomarkers, these organic compounds are detected in urine, blood, skin or in expired air^{3,4,5,6}. Although the composition of the samples varies greatly between patients, and despite VOCs being present in very low concentrations (pptv to a few ppmv), certain pathologies can be detected and followed by breath analysis⁷.

The analysis of expired air still requires specific, expensive and bulky equipment, qualified personnel and long analysis times. To promote and spread early diagnosis using breath analysis, especially among general practitioners, it is necessary to develop simple, compact and efficient systems such as multi-sensor systems, also called electronic noses. The performance of these systems is based on the use of sensors with various specificities associated with high sensitivities to target VOCs.

This PhD thesis aims at the development of organic transistors dedicated to the detection of cancer biomarkers, in the form of VOCs. It has 4 main axes: (i) the formulation and elaboration of organic nanocomposites with properties adapted to the detection of specific VOCs in the context of breath analysis, (ii) fabrication of conventional sensors and analysis of their response in a controlled gaseous medium, (iii) integration of the organic nanocomposites in organic transistors and (iv) characterization of the transistors, or even of a multi-transistor system, in controlled gaseous medium. The project will allow on the one hand to develop the scientific knowledge of the interactions between the functional materials and the targeted VOCs, and on the other hand to develop high sensitivity sensors for the early diagnosis of cancer. The PhD will be conducted in close connection to the European project Interreg PATHACOV¹⁰.

European project and collaboration context

As mentioned, the PhD thesis will contribute to the European project PATHACOV, for which two French laboratories will collaborate to the development of organic-transistor based sensors. The PhD thesis will be carried out in two locations: in the laboratories of the Institut Mines Télécom (IMT) in Douai, and the University of Reims Champagne-Ardenne (URCA) in Reims. The PhD student will benefit from the gas detection expertise of the Atmospheric Sciences and Environmental Engineering (SAGE) laboratory of IMT, and the skills in organic electronics of the Nanoscience Research Laboratory (LRN) from URCA. Accommodation and transport between the two sites, 165km apart, will be facilitated and organized so as to provide a good working environment.

The SAGE laboratory, which specializes in environmental themes related to indoor and outdoor air quality, has state-of-the-art skills in gas detection, which have been extending to the health field for several years. Within

this project, SAGE will bring its expertise in the development of sensitive polymers, in sensor metrology, and in the design and analysis of multi-sensor systems.

The LRN specializes in nanotechnologies, nanomaterials and near field instrumentation. Within the project, LRN will bring its knowledge of semiconductor device physics and organic electronics, of the fabrication and of the characterization of thin film transistors.

Both laboratories are equipped with state-of-the-art equipment in their respective field.

Key words: Nanocomposites, sensors, cancer diagnosis, volatile organic compounds, organic transistors, multi-sensor system

Profile: we are looking for a candidate with knowledge in materials or polymer chemistry, basis in semiconductor physics, with a pronounced interest for sensors and data analysis. Curious, the candidate will feel confident in an interdisciplinary and international environment. English skills are mandatory (speaking/reading/writing).

Laboratories: [SAGE/IMT Lille Douai¹¹](#), team 'electronic sensors', and [LRN/URCA¹²](#), team 'Nanomaterials and applications'.

Doctoral school: [Sciences Fondamentale Santé](#) of [Université de Reims Champagne Ardenne](#)

Salary : 1420€ (net/month), 36 months

Contacts: PhD supervisors and teams

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Application: candidates must send a CV, a motivation letter and recommendations, and two last year records to both the IMT Douai and URCA contacts.

References

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