Ph.D. thesis position

Laboratoire
d'électronique
et de technologie

Field of research :

Chemistry for nanos	☐	Molecular electronics	☐	Process Technologies	☐
Imaging devices & Systems	☐	Nanocharacterization	☐	RF Devices & Systems	☐
Materials	☐	Nanoelectronics	☐	Spintronics	☐
Memory technologies	☐	Nanos for Energy	☐	Autres	☒
MEMS and sensors	☒	Nanoscale simulation	☐		
Microtechnologies for bio	☒	Photonics	☐		

Initial training	Duration in months	Date starting up	For internship : possible PhD thesis (yes/no)	Funding
Masters's degree or equivalent	36	Nov. 2016		

Title : Biomimetic capture of odor molecules in microfluidic systems

Collaboration framework and context:

The olfactory system in vertebrae is based on a limited set of neuronal receptors that stills enable the identification of a very large number of odor molecules. These molecules can be detected and identified even at extremely low concentration. Our noses are capable of surprising prowess thanks to structures and functions that have no matches in the technological realm. Indeed, performances in odor perception of the animal kingdom outperform artificial sensors derived from micro and nano-technologies by several orders of magnitude (electronic noses, NEMS/MEMS sensors, MOX sensors). This Ph.D. position, right at the interface between biology and microtechnology aims at understanding and re-creating some of the functions observed in mammals for capture of odors molecules in small amount, with a focus the "integrated systems" that constitutes living organisms. Indeed the work will not be centered on technological development but will rather focus on a "co-evolution" of the different system's components. The Ph.D. student will share his time between LETI/Carnot Institute in Grenoble for the microfluidic and sensors part and Tours University/CNRS for the biological part and flux imaging experiments.

Description of workplan:

During a first period, a synthesis of state-of-the-art knowledge will be written for the biological aspects as well as for the technological aspects. The vertebrae system (man, dog, frog) will be analyzed along with the different gas sensors fabricated from micro and nanotechnologies. This synthesis will be eased by the development of both deterministic and stochastic analytical models of reaction-advection-diffusion reinforced by a multi-physics modelling approach through finite element models. In this period we will aim at identifying and model transport mechanisms that explains performances of animal systems. Second phase will be foremost experimental. It will consists in the fabrication of a microfluidic system that will mimic the main characteristics of the transport chain of interest. The addition of a liquid phase component constitutes an original starting point for this work. In particular, aqueous solutions and gels materials with different properties will be evaluated so to realize a biomimetic "mucus". The dynamics of odor particles at the air/mucus interface and the transport characteristics of the mucus substrate (speed, directionality, flux regeneration) will be studied. Flux imaging will be performed via PIV (Particle Image Velocimetry) and TOMO-PIV techniques. Shuttling between measurements and fabrication will be necessary to obtain a sufficiently integrated demonstrator. The ultimate goal for this Ph.D. is to identify and understand the key mechanisms that will enable in the future to aim at sensors systems with similar performances than a dog nose for instance. Ph.D. work will be co-localized at Tours University and at LETI (CEA Grenoble) and will start at Tours University.

Host institution:

PhD Thesis Director	Technical Supervisors
Prof. Jérôme Casas (University of Tours, Insect Biology Research Institute (IRBI) CNRS UMR 7261, Faculty of Science and Technology, Avenue Monge, Parc Grandmont 37200 Tours) jerome.casas@univ-tours.fr	Dr. Yves Fouillet (CEA-LETI, DTBS/SBSC/LBAM, 17 rue des Martyrs 38054 Grenoble CEDEX 9) Tel.: 04.38.78.92.74 yves.fouillet@cea.fr Dr. Thomas Alava (CEA-LETI, DCOS/SCMS/LCMC 17 rue des Martyrs 38054 Grenoble CEDEX 9) Tel.: 04.38.78.07.75 thomas.alava@cea.fr