



Laboratoire de l'Intégration du Matériau au Système CNRS UMR 5218

PHD POSITION 2023

STUDY OF THE RELIABILITY OF RESONANT MEMS USED FOR THE MEASUREMENT OF PHYSICAL PROPERTIES OF GASES

CONTEXT / BACKGROUND

Classically, silicon microcantilevers or arrays of micromembranes (CMUT: capacitive micromachined ultrasonic transducers) obtained by fabrication techniques derived from those of microelectronics can be used as chemical microsensors. For this purpose, a sensitive layer is deposited on the microstructure. Its role is to selectively capture the chemical species to be detected. The absorption of compounds by this layer modifies, among other things, the mass of the system and thus its resonance frequency. The chemical detection of a given gas is then obtained by measuring the resonance frequency of the sensor covered with the appropriate sensitive layer. In the Organic group of the IMS Lab, it was validated that it is possible to make chemical detection using resonant MEMS without using a sensitive layer. In this case, the chemical detection and discrimination between different gases is done via the measurement of several physical characteristics of the gas in which the resonant MEMS vibrates: density, viscosity, speed of propagation and attenuation of mechanical waves, ... The fact of no sensitive layer is required for such MEMS sensors allows to have generic sensors and not dedicated to a chemical species. The reliability of chemical sensors and their lifetime are generally attributed to the premature aging of the sensitive layer that cause drifts and a decrease in sensitivity over time. It is therefore important to quantify the improvement brought by the removal of the sensitive layer on the aging of sensors

PHD SUBJECT

The main goal of this PhD thesis is to characterize the aging of MEMS sensors (microcantilevers and CMUTs) that are used at IMS to perform chemical detection without using a sensitive layer. The results obtained should make it possible to identify the failure modes and mechanisms, to quantify the interest of not using a sensitive layer for chemical detection and to determine the limits of use in severe environments.

The resonant MEMS that will be used are silicon microcantilevers and CMUTs fabricated at LAAS (Toulouse, France) and at GREMAN (Tours, France), respectively. The sensors will be assembled on PCB type substrates and will be subjected to aging tests. These tests will be representative of environments for which the chemical sensors are intended. The tests will implement chambers for thermal storage, thermal cycles, humidity tests as well as a shaker and a bending test bench for mechanical tests. These different tests can be carried out with the aging equipment of the IMS laboratory. First of all, it will be necessary to carry out series of measurements of the physical parameters of the sensor during a first series of aging tests. These values will be compared with the initial values in order to determine the measurable parameter representative of aging. A value of this parameter will then be defined as a failure criterion for the next aging tests. They will be performed on sensors alone and encapsulated in a packaging in order to determine the aging of the sensor and interconnections. This will allow to identify the first failure site, at the silicon component level or at the assembly level and the first failure mechanism. In order to characterize the influence of aging on the characteristics of the sensors, chemical detections will be performed before the first aging tests and at each stage of the aging tests.

LABORATORY/SUPERVISORS

The work will be carried out in the IMS Laboratory (Laboratory from the Integration from Material to System de l'Intégration du Matériau au Systèmes, UMR CNRS 5218). Reliability Group and Organic Group : Université de Bordeaux, Bâtiment A31, 351 Cours de la Libération, 33 400 Talence, France

The PhD work will be supervised by Isabelle Dufour and Alexandrine Gracia.

DURATION/FUNDING

- Duration: 3 years
- Starting date: flexible September/October 2023
- Gross monthly salary: 2000 €
- Net monthly salary: 1600 € with the social insurance included.
- Tuitions fees for doctoral student: ~400€/years
- Information on studies, daily life and campus life can be found on https://www.u-bordeaux.fr/application/files/5916/5830/6502/2022_Guide-etudiant_Student-guide.pdf

RESEARCH PROFILE

- The recruited candidate should have a strong scientific background, demonstrate good skills in the field of instrumentation, and show scientific curiosity and adaptability to a new field.
- Knowledge in MEMS and/or reliability will be appreciated.

APPLICATION

- Candidates should send a CV and a letter of motivation as soon as possible to Isabelle Dufour (isabelle.dufour@ims-bordeaux.fr) and Alexandrine Gracia (alexandrine.gracia@ims-bordeaux.fr). Please use your name to name the electronic files you send as attachments.