LMGP
Laboratoire des matériaux et du génie physique
une vision des matériaux

2020-2021 Internship proposal at LMGP Lab.

# Design of a setup for actuation and measurement of a cantilever-based gas sensor


## Abstract

The object of this internship is to design and test a measurement setup that can be employed for excitation and measurement of a dynamic-mode cantilever gas sensor. The study involves schematic design and fabrication of a sensor chamber that comprises a piezoelectric component for actuation and signal detection.


In the global markets of sensors and sensing technologies, the interest in gas sensors is rapidly increasing. Gas sensors have a vast variety of applications such as toxic gas detection, air quality monitoring, and early disease detection. The fast development of gas sensor technology requires to improve the sensing properties, e.g. fast response, enhanced detection limit and high sensitivity. Accordingly, quite of number of ultrasensitive gas sensors have been developed, including dynamic cantilever sensors.

A cantilever is typically a micro-scale rectangular beam where its surface is sensitized to a target molecule. The dynamic cantilever oscillates at its natural resonance frequency, commonly by MEMS (Micro-Electro-Mechanical System) based actuation method. Adsorption of an analyte on the cantilever surface changes its mass and/or stiffness, resulting in a frequency shift. This shift is detected by a read-out technique and gives us information about the analyte. These resonant gas sensors have several prospective advantages over the conventional technologies as they are ultrafast, sensitive and able to make indirect mass change estimation down to level of a few, or even a single, molecule in the atto or zepto gram range. Moreover, they can be operated in vacuum, air or liquid.

Several factors can affect the performance of the cantilever sensors, including size, geometry, material, more order, mode type, sensitive coating, sensing medium, recognition chemistry, actuation and measurement scheme, etc. The cantilevers are fabricated in different geometries (e.g. rectangular, paddle shape, U shape, etc.) from different materials like silicon, polymers, ceramics, etc. Sensor arrays can be excited and measured by piezoelectric, optical, electrostatic, etc. components.

A measurement setup for a cantilever-based sensor commonly consists of several parts:

1) The sensing chamber containing the cantilever arrays

2) A gas or liquid handling system to reproducibly inject samples into the sensing chamber and purge the chamber

3) An actuation component (e.g. piezoelectric device) to vibrate the cantilever to its resonance frequency

4) A measurement system (e.g. laser sources or interferometer) to detect the frequency shift

5) Electronics to amplify, process and acquire the signals from the detector

We are currently developing innovative cantilever sensors to improve selectivity and sensitivity, for which we need to implement a measurement set-up.

## Project description

Within this context, the internship will focus on the development of a measurement setup for a cantilever-based gas sensor. It includes contribution to the design of the sensing chamber and its assembly.

### Related Publications


Lang, Hans Peter, Martin Hegner, and Christoph Gerber. "Nanomechanical cantilever array sensors." Springer Handbook of Nanotechnology. Springer, Berlin, Heidelberg, 2017. 457-485.

Johnson, Blake N., and Raj Mutharasan. "Biosensing using dynamic-mode cantilever sensors: A review." Biosensors and bioelectronics 32.1 (2012): 1-18.


## Scientific environment:

The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, in the Funsurf group in collaboration with the neighbour TIMA laboratory. .

Located in the heart of an exceptional scientific environment, the LMGP offers the applicant a rewarding place to work. LMGP Web Site: http://www.lmgp.grenoble-inp.fr/

## Profile & requested skills:

The candidate must have a good ranking (top 25%) in a master or engineering school. Ideally, the candidate should have interest and background in MEMS and electrical engineering. We are looking for a highly motivated student who is interested to work in an interdisciplinary group as well as someone with a dynamic attitude and good communications skills. The candidate should be fluent in English and ave good presentation and writing skills.

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**Subject could be continued with a PhD thesis**: YES provided there is funding

**Allowance:** Internship allowance will be provided

**CONTACT**

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