

Internship proposal (Master 2 or final internship)

MOF-based resonant gas sensors

1) Context & objectives :

This internship is part of a collaborative research effort between the LMGP and TIMA laboratories focused on the design, fabrication, and characterization of new resonant gas sensors. It follows the PhD work of M. Akbari [1,2,3], which dealt with the design and fabrication of micro-sensors based on MOF (Metal–Organic Framework) sensitive layers conformally deposited on MEMS cantilever-type structures. That thesis highlighted the advantages of combining the unique physico-chemical and structural properties of ultrathin MOF layers with the high performance of resonant sensors.

During this internship, we aim to explore the localized deposition of MOF layers on piezoelectric silicon MEMS (PiezoMEMS) that have already been designed and fabricated. For this purpose, two deposition methods are considered in the project: (i) Spatial Atomic Layer Deposition (SALD) — either through traditional selective deposition techniques or approaches developed at LMGP [4,5] and (ii) Capillary printing (NAZCA), a very recent technology that allows printing from very small volumes and achieves line resolutions of less than one micrometer. The deposited materials will be characterized using standard techniques available in the laboratory.

To assess the impact of localized MOF deposition, the following steps will be undertaken:

- Perform electromechanical characterizations of the bare MEMS (TIMA) to identify the natural vibration modes of clamped-free and clamped-clamped beam structures.
- Carry out localized MOF depositions (LMGP).
- Evaluate the influence of the MOF layers on the electromechanical characteristics of the sensors (TIMA & LMGP).

Depending on the progress of the internship, it may also be possible to characterize the sensors in a dedicated gas-testing setup (for example, with humidity, acetone, etc.) (TIMA & LMGP).

The internship will take place jointly between the TIMA and LMGP laboratories, both part of the Fédération des Micro et Nanotechnologies. The labs will provide access to electromechanical characterization tools and MOF deposition equipment (SALD, NAZCA) necessary for fabricating these sensors.

2) Practical information :

- Level: Master 2 or Engineering School (final-year internship)
- Duration: 6 months
- Required skills: Materials science, knowledge of sensors and MEMS, electrical characterization, and familiarity with thin films and nanotechnology, proficiency in English and ability to work in a team.

3) Supervisors :

At LMGP :

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At TIMA :

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4) References:

- [1] Open air fabrication of oxide-based cantilever gas sensors. Masoud Akbari PhD UGA – 2023
- [2] Gas phase growth of metal-organic frameworks on microcantilevers for highly sensitive detection of volatile organic compounds. M. Akbari et al [APL Materials](#), **2024**, *12*, 061119.
- [3] NEMS generated electromechanical frequency combs. S. Rahmanian et al *Microsystemes & nanoengineering* **2025**, *11*, Article number: 8
- [4] C. Masse et al., [Coatings](#), **2018**, *9*(5), 5.
- [5] C. Masse et al.. [Advanced Materials Technologies](#), **2020**, *5* (12), 2000657.