Development of a microsensor for fungal alert and mass concentration measurement of bioaerosols.

Keywords : aerosols metrology, modeling, MEMS, air quality, aerosol impaction bench.

Location: - CERTES (EA 3481) - Université Paris-Est Créteil
- ESYCOM (UMR 9007 CNRS) - ESIEE Paris - Université Gustave Eiffel
- CSTB - Champs sur Marne

Hosts laboratories

The thesis will take place within the framework of a collaborative research effort and under a co-supervision agreement between three laboratories: the CERTES laboratory (Center for Thermal, Environmental, and Systems Studies), the ESYCOM laboratory (Electronics, Communication Systems, and Microsystems), and the CSTB (Scientific and Technical Center for Building).
Within this framework, the thesis work will be conducted jointly between the three institutions.
The different teams in which the future doctoral student will work possess specific expertise and skills: ESYCOM/ESIEE in micro/nanofabrication and electrical and mechanical characterization of microsystems, CERTES in aerosol physics, and CSTB in bioaerosol detection.
For several years, the CERTES of the Université Paris-Est Créteil Val de Marne (UPEC) and the CSTB have been collaborating on research in aerosol physics and metrology.
The ESIEE team at the ESYCOM laboratory has particular expertise in microsystems and microtechnology and benefits from the technological means of microfabrication, as well as the expertise of personnel in the cleanroom facility at ESIEE.

Abstract

This research work is part of the continuity of three theses in collaboration between CSTB, CERTES/UPEC, and ESYCOM/ESIEE on the development of a mass micro-particle sensor for analyzing air quality from the perspective of particulate pollution.
In the scope of Brice Berthelot's thesis (Berthelot, B., 2015), the initial design foundations of a micro-sensor dedicated to indoor air particle monitoring were established, focusing on the design and modeling of a MEMS microbalance capable of real-time measurement of the mass of particles deposited on its surface. A second thesis, by Ugur Soysal titled "Study and design of MEMS microbalances for aerosol detection in indoor environments," led to the refinement, fabrication, and testing of the microbalances. A proof of concept for measuring deposited mass using silicon MEMS microbalances was demonstrated. A micro-impaction device for particle sampling was developed, and surface functionalizations (via micro/nanostructuring of Silicon) were studied to enhance collection efficiency. A third thesis by Antonella Al Najjar, "Development of surfaces for optimizing aerosol collection by micro-impaction and surface regeneration: Application to bioaerosols," aimed to investigate the specific adhesion

and collection properties of bioaerosols on functionalized and microstructured surfaces. In the course of this work, specific collection properties and surface regeneration demonstrations were carried out.
With the goal of creating a device incorporating mass measurement per size class (PM1, PM2.5) and fungal alert based on the quantity of aerosols collected on a hydrophobic surface, the future thesis will focus on optimizing collection for different particle sizes, integrating functionalized surfaces on microbalances, and studying hydrophobic surfaces.

Main objectives

The various tasks of this work will include:

1. Studying impaction according to parameters and the shape of structured patterns on a surface.
2. Performing collections of granulometric fractions by optimizing the cut-off diameter of micro-impactors and surface properties.
3. Integrating these surfaces into an impaction-based aerosol sensor.
4. Studying hydrophobic surfaces enabling the preferential adhesion of fungal particles and detachment (e.g., by varying the actuation frequency of the microbalances) of hydrophilic particles.

Thus, a sensor prototype could be proposed for the simultaneous measurement of PM concentration and fungal presence alert continuously in situ, in real-time, in both indoor and outdoor environments.
The proposed work will continue studies on functionalized and micro/nanostructured surfaces of MEMS microbalances and their collection properties, integrating them into a specific sensor for real-time measurement of particulate mass concentrations. This thesis will contribute new knowledge on specific surface hydrophobic regeneration according to the hydrophobicity/hydrophilicity of aerosols. These properties will be identified and exploited for the realization of a specific sensor for fungal aerosol detection. The work will be subject to at least one scientific publication in a peer-reviewed journal.

Terms and conditions of employment

Profile:

- Master's degree or equivalent in micro-nanotechnology.
- Knowledge in sensor physics, physicochemistry of surfaces, and fluid mechanics is expected.
- Knowledge in aerosol physics would be appreciated.

Application: CV and cover letter have to be sent to :

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