PhD Position

Dynamic and self-regulating porous devices for sensing and encryption

The problem Colorimetric sensors are increasingly attractive for detecting hazardous gases such as hydrogen (H_2) and volatile organic compounds (VOCs) because they offer a simple, power-free, and immediately interpretable response. Unlike conventional analytical instruments that require bulky equipment and trained personnel, colorimetric systems translate chemical interactions into visible color changes that can be recognized by the naked eye. This makes them ideal for rapid on-site screening in industrial, environmental, or safety-critical settings. Their compatibility with smartphone cameras further enhances sensitivity and reliability, enabling quantitative analysis through image processing while maintaining portability and low cost. Yet, developing materials that change color in a robust, selective, and clearly detectable way remains a significant challenge.

Our approach To tackle this challenge, inspired by the dynamic camouflage strategies of cephalopods (similar to dynamic optical illusions), our approach builds on a family of self-regulating, dynamic metasurfaces that we have recently developed (1) (2) (3) and the use of dynamic patterns (including optical illusions). By harnessing the intrinsic sorption properties of these porous frameworks, we design internal amplification or damping mechanisms that modulate optical responses in a controlled way, enabling strong, reliable, and detectable color variations upon gas exposure. In addition, we will explore these approaches for encryption in order to store information.

What is our goal?
More specifically, the project aims to:
- (i) Synthetize the porous materials coupled with photothermal materials to induce self-regulation
- (ii) Integrate and pattern the porous systems into a macroscopic device by lithography and 3D printing
- (iii) Evaluate the gas detection and dynamics performance by optical methods such as in situ ellipsometry and hyperspectral microscopy (4), as well as by smartphone imaging
- (iv) Create dedicated image-analysis strategies to accelerate material screening and optimization (selectivity and sensitivity).

Profile: We are seeking a candidate with material's chemistry background with experience in (optical) sensing and/or processing/patterning nanomaterials, porous materials, thin films. A solid background in building experimental setups and data and image analysis is a plus. The ideal candidate should also possess strong communication and writing skills.

Location/supervision: The contract duration (36 months). The candidate will work at Laboratoire Chimie de la Matière Condensée de Paris at Sorbonne Université downtown Paris. The post-doc project will be supervised by Pr. Marco Faustini.

How to apply? The applicant will attach a CV and the contact of 1 or 2 references he/she worked with.

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(1) *Self-regulating and self-oscillating Metal-Organic Framework hybrid plasmonic metasurfaces* H. Amyar, D. R. Ceratti, H. Benisty, A. Cattoni, M. Besbes, M. Faustini Nature Communications, 2025 10.1038/s41467-025-65338-2
(2) *A Homeostatic Photonic Device Integrating Vapor-Regulated Thermo-Optical Feedback Mechanisms* C. Byun, D. R Ceratti, C. Mimoso, C. Boissière, M. Faustini Advanced Functional Materials 35, 2424453, 2025
(3) *Metal–Organic Framework photonic balls: single object analysis for local thermal* probing C. Avci; M. L. De Marco; C. Byun; J. Perrin; M. Scheel; C. Boissière; M. Faustini Advanced Materials, 33, 2104450, 2021
(4) *Programming crack patterns with light in colloidal plasmonic films.* F. Thorimbert, M. Odziomek, D. Chateau, S. Parola, M. Faustini Nature Communications 15, 1156, 2024