

The Softmat laboratory

The laboratory of **Chemistry of colloids, polymers & complex assemblies** is dedicated to research into the **chemistry of soft matter**. It focuses on the design of organized systems made up of surfactants, polymers, biomolecules or nanoparticles. Our skills in analytical chemistry, physical chemistry and photochemistry also enables us to accurately assess the structure/properties relationship of these responsive objects. This research is the subject of frequent collaborations with academic or industrial partners, and thus helps to meet the scientific and societal challenges of our time. The lab is based in the south of France, in the city of Toulouse. Have a look to our website: <https://softmat.fr/en/>

The PhD topic : NIR-fueled fluorescent Microbeads for velocity and O₂ sensing

Operation of a **bioreactor** can be affected by local concentration gradients of dissolved dioxygen and H₃O⁺. O₂ is often introduced by bubbling air or pure gas into the medium and its dissolution depends on **local fluid flows**. Their mapping as well as the monitoring of **dioxygen** and **pH** is thus critical. Determination of fluid's local velocity is usually achieved using particle image velocimetry (**PIV**), while local [O₂] and pH can be measured optically using fluorescent dyes, resp. being O₂-quenched or acidochromic. Unfortunately such dyes are usually operated in the same visible light range. The French *National Research Agency*-funded "**Odysseus**" research program (Optimization of carbon Dioxide and oxYgen maSS transfer in biorEactors: a mUltiscale Study, ANR-23-CE51-0002) associates a chemistry team (*SOFTMAT*) and a biochemical engineering one (*TBI*, from INSA Toulouse, **Pr N. Dietrich**, <https://bit.ly/45X6OEx>) to address *inter alia* this issue. **The PhD topic is the preparation and calibration** of a set of **O₂-sensing, PIV beads** of various sizes and types, inspired from the "SensPIV" concept¹ but driven in the NIR range thanks to the incorporation of **upconverting nanoparticles** (UCNPs).² Indeed, thulium-doped UCNPs can convert NIR light (i.e. 800nm) into blue one, that spectrally matches the O₂-probe [Ru(bathophen)₃]²⁺, a dye used by the TBI team.³ Such beads will be therefore excitable independently from a dissolved pH sensor. The proposed area of research encompasses various fields from molecular, nanoparticle & polymer chemistry to physical chemistry (luminescence studies), in line with ongoing projects of local laboratories belonging to the *FERMaT Research Federation* (FR 3089).

References: (1) Ahmerkamp, S. *et al.* Simultaneous Visualization of Flow Fields and Oxygen Concentrations to Unravel Transport and Metabolic Processes in Biological Systems. *Cell Rep. Methods* **2022**, *2*, 100216. <https://doi.org/10.1016/j.crmeth.2022.100216>; (2) Q. Zou, *et al.* Heterogeneous Oxysulfide@Fluoride Core/Shell Nanocrystals for Upconversion-Based Nanothermometry *ACS Nano* **2022**, *16*, 12107–12117 <https://doi.org/10.1021/acsnano.2c02423>; (3) Lebrun, G. *et al.* Luminescent Probe Synthesis for Oxygen Visualization Technique: Application to the Effect of Surfactant Structure on Oxygen Mass Transfer. *Chem. Eng. Sci.* **2022**, *260*, 117921. <https://doi.org/10.1016/j.ces.2022.117921>.

The applicant

Candidates should have a Master's degree in Chemistry. The skills required lie in the field of soft matter (inorganic and organic colloids) and analytical chemistry.. Scientific curiosity and social skills will be appreciated.

Salary: €1,900 net per month for 36 months.

Expected start: October 2024.

Supervision: Christophe Coudret

Apply through the CNRS Job Offer portal: <https://emploi.cnrs.fr/Offres.aspx>

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