Toulouse Biotechnology Institute
Bio & Chemical Engineering

PhD Position

From particles at droplet interfaces to functional micro-bioreactors

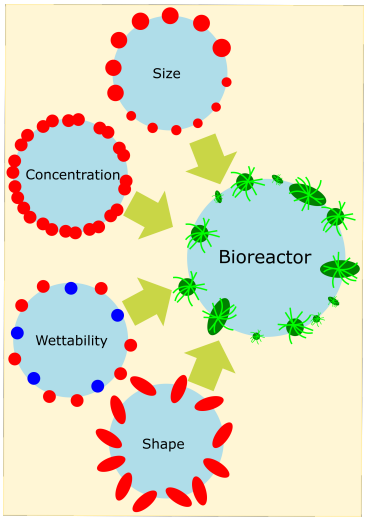
Supervision: Mickaël Castelain (castelai@insa-toulouse.fr), Loïc Chagot (lchagot@insa-toulouse.fr)
Location: Transfer-Interface-Mixing of TBI at INSA Toulouse, France
Gross salary: ∼2300€/month (INSA contract) with possibility to teach (extra ∼200€/month)
Start: October 2026

Project

Thanks to their high reproducibility, microfluidic devices enable the controlled generation of microdroplets that encapsulate biological particles (cells, bacteria, enzymes, etc.) and act as micro-bioreactors, which has driven their significant growth in biotechnology. However, the presence of bioparticles at interfaces can significantly alter droplet-reactor formation and performance. These effects remain poorly understood and quantified, leading to the following question:

How do bioparticles control droplet formation, stability, and hydrodynamics in microfluidic systems?

The main objective of this PhD project is to understand and quantify the influence of bioparticles on the formation dynamics and final properties of microfluidic droplet-reactors.



Synthetic particles mimicking key properties of bioparticles (size, concentration, wettability, rigidity) will be used to systematically isolate the influence of each parameter. Droplet formation dynamics will be investigated using high-speed shadowgraphy, with particular focus on particle-induced modifications of neck thinning, and compared with classical models for particle-free interfaces. Internal droplet circulation and mixing will be analyzed using 2D–2C Particle Image Velocimetry (PIV) and a holographic Particle Tracking Velocimetry (holo-PTV) system currently under development within the TIM team at TBI. Particle–interface and particle–particle interactions at the single-particle scale will be explored using optical tweezers. Finally, selected bioparticles will be studied to validate the models and hypotheses developed during the project.

You will be entrusted to provide fundamental advances in the physics of particle-laden droplet formation and will contribute to the optimization of microfluidic systems for biotechnology and bioprocessing applications.

Candidate profile

You should hold a Master's degree in chemical engineering, fluid mechanics, physics, or a related field. Strong knowledge of multiphase flows and microfluidics is required. A genuine interest in experimental work, image processing, and biotechnology applications is expected. Sufficient proficiency in English for scientific writing and international conference presentations is mandatory.

How to apply?

Send a cover letter, a detailed CV, transcript of Master diploma and one reference contact.
The interview will operate under rolling basis. Deadline of submission : 15th May 2026

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