

ITI HiFunMat Master Internship Proposal

M 1

M 2

Title: Modelising the pore growth in polyurethane matrices through a microfluidic setup

Internship supervisor

Name, first name	Wiebke Drenckhan-Andreatta & Luca Fiorucci
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Laboratory	Institut Charles Sadron (collaboration with BASF Polyurethanes)
Collaboration with a HiFunMat member (<i>please indicate their name</i>)	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes : Wiebke Drenckhan-Andreatta

Student profile looked for

Master program (<i>more than one box can be ticked</i>)	<input checked="" type="checkbox"/> Material science and engineering <input checked="" type="checkbox"/> Chemistry <input checked="" type="checkbox"/> Physics
Other indications if necessary	

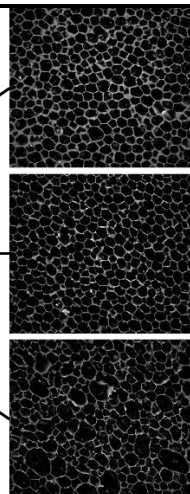
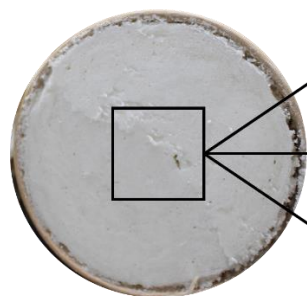
Internship description

Description

Over the last few decades, polyurethane foams have become the most widely used insulation material in the world and a key tool for achieving the climate goals of the Paris Agreement. The insulating properties of such materials depend largely on the morphology of their pores (e.g. size, connectivity). Although much effort has been made to understand the effect of different additives on the nucleation and to model the growth rate^{1,2}, a quantitative link between the used formulation, the nucleation rate and the growth rate of the pores is still lacking.

In the MIM (Mechanics of Interfaces and Multiphase Systems) team of the Institut Charles Sadron, and in collaboration with the multinational company BASF, we are therefore developing dedicated, microfluidic model experiments to elucidate the underlying processes.

As a first step, the internship student will optimise an existing microfluidic chip³ with respect to the chemical resistances of the chip and the architecture of the channels. He/she will then use this chip to quantitatively link and model the growth rate^{4,5} of gas bubbles in matrices of different compositions. The final aim of the internship will be to compare different additives in terms of their ability to nucleate, stabilise and grow pre-existing bubbles.



Cross-section of a polyurethane foam (left); Micrographs showing various foam morphologies after using different additives (right)

Requirements and application

We are looking for a highly motivated Masters 1 student with a background in physical chemistry, chemistry or material science and a strong interest in learning new techniques (CNC-milling, microfluidics, contact angle measurements, optical characterisation methods, etc.). The candidate should have a good level of English. French and German are an advantage. The intern will contribute on an international collaboration between the CNRS and our industrial partner BASF. He/she will work inside the ‘Mechanics of Interfaces and Multiphase Systems’ (MIM) team at the Charles Sadron Institute, an internationally renowned research unit of the CNRS, investigating various topics related to polymers and material science.

In case of interest, please submit your application (including CV and cover letter) to Dr. Wiebke Drenckhan-Andreatta (Wiebke.Drenckhan@ics-cnrs.unistra.fr) and Luca Fiorucci (Luca.Fiorucci@ics-cnrs.unistra.fr). The internship will take place at the Charles Sadron Institute which is located in a ZRR (zone à regime restrictif).

References

- (1) Pérez-Tamarit, S.; Solórzano, E.; Mokso, R.; Rodríguez-Pérez, M. A. In-Situ Understanding of Pore Nucleation and Growth in Polyurethane Foams by Using Real-Time Synchrotron X-Ray Tomography. *Polymer (Guildf)* 2019, 166, 50–54.
- (2) Blander, M.; Katz, J. L. Bubble Nucleation in Liquids. *AIChE Journal* 1975, 21 (5), 833–848.
- (3) Pivard, S.; Hourlier-Fargette, A.; Cotte-Carluer, G.; Chen, D.; Egele, A.; Lambour, C.; Schosseler, F.; Drenckhan-Andreatta, W. Bubbling up in a Lab-on-a-Chip: A Gravity-Driven Approach to the Formation of Polyelectrolyte Multilayer Capsules and Foams. *Colloids and Surfaces A* 2024.
- (4) Katz, J. L. Bubble Nucleation in Liquids.
- (5) Lubetkin, S. D. The Fundamentals of Bubble Evolution.