Institute	CINaM - UMR 7325 CNRS - Aix Marseille Université Campus de Luminy – Case 913 13288 MARSEILLE Cedex 09 https://www.cinam.univ-mrs.fr/
Department	Local Probes and Sources
Themes	Fields at Nanoscale Localized Phenomena and Microfluidic
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PhD proposal

Integration of intense localized electric fields in microfluidics to study nucleation.

Keywords: nucleation / microfluidics / nanoelectrodes / crystals / bubbles

Studying nucleation is confronted with the stochasticity of the phenomenon: we do not know where, when, or how many events will emerge. If statistical approaches shed light on this behavior, many uncertainties remain, preventing a fine knowledge and control of this major physical phenomenon, involved in the production of products of pharmaceutical interest (crystal nucleation) as well as in our predictive capacities in meteorology or climatology (droplet and crystal nucleation).

Among the external fields able to limit the stochasticity of nucleation and to offer a more serene framework for its study, intense localized electric fields have demonstrated their ability to control the spatial and temporal localization of crystal or bubble nucleation, and would greatly benefit from a coupling with statistical approaches as offered by microfluidics.

This PhD project aims at developing and integrating nanometric platinum electrodes (tips with a radius of curvature of the order of 10nm) in microfluidic chips. The effect on the nucleation of such nanoelectrodes will be studied on the nucleation of gas bubbles (localized electrolysis of water), first in continuous flow (water), then in dispersed flow (water drops conveyed by an oil phase).

The nanoelectrodes will be produced by electrochemical etching, and characterized by electron microscopy. The microfluidic chips, to be designed, will be based on the use of various technologies at our disposal (3D printing, HPLC tubing, maskless photolithography). The observations of bubble nucleation will be done by optical microscopy and image analysis (ImageJ/Python).

This PhD project has a strong experimental component, and requires work, motivation, meticulousness and inventiveness. The strong supervision reveals both the multidisciplinary aspect of the subject (thus requiring organizational skills and autonomy) and the involvement of the department. Funding will be provided after selection by the doctoral school 352 of Aix Marseille Université (Submission of applications April 2024).
The thesis laboratory, CINaM, is located on the Luminy campus, in the heart of the Calanques National Park.