

PhD Opportunity

Nanoscale Characterization of Polymer Interphases using IR nanospectroscopy Techniques – AFMIR

Location: ICP (Institut de Chimie-Physique), Paris-Saclay University, Orsay and PIMM Laboratory, Arts et Métiers Institute of Technology, Paris, France. Short stays at IFPEN (Rueil-Malmaison) are envisioned towards the end of the project.

Duration: 3 years

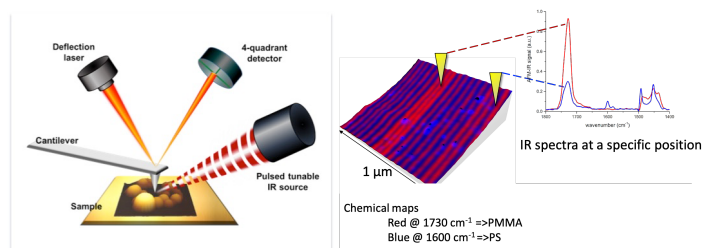
Start: Fall 2025

Funding: DIM MaTerRE PhD Fellowship Program 2025 (already acquired)



Project Overview

The growing need to improve plastic recyclability and design high-performance, environmentally sustainable polymer materials calls for a deep understanding of **polymer-polymer interphases** — nanometric regions that govern the mechanical and chemical properties of polymer blends and multilayer films used in packaging. This PhD project centers on the **nanoscale characterization of these interphases** using **AFM-IR (Atomic Force Microscopy–Infrared Spectroscopy)** — an advanced technique developed at **ICP** to perform **infrared spectroscopy at the nanoscale**.



Through a strong collaboration with the **PIMM** lab, known for its expertise in **multinanolayer polymer coextrusion**, the candidate will analyze model systems and industrially relevant films (e.g., PET/PEF), with a particular focus on interfaces, compatibilizers, and recycled content through a collaboration with **IFPEN**, an institute expert in renewable resources.



Scientific goals

Develop and optimize **AFM-IR measurement protocols** for polymer interfaces. Quantify at the nanoscale and correlate chemical and mechanical properties of polymer interphases. Investigate compatibilizers and interphase stability across virgin and recycled polymers.



Methodology

AFM-IR and photothermal IR spectroscopy for high-resolution chemical imaging. Development of calibration protocols and multimodal data analysis. Extension to aged and recycled materials to assess interface evolution.

Candidate Profile

We are looking for a highly motivated student (MSc degree or equivalent) with:

Strong background in **physics of complex or soft matter, physical-chemistry, molecular spectroscopy, polymer science.**

Experience or interest in **development and characterization at the nanometric scale - vibrational spectroscopy** (IR/Raman).

Basic skills in Python programming and **data analysis.**

Proficiency in English (B2 minimum).

Work in multidisciplinary dimension, with potential travel abroad for collaborations and training (especially in data analysis).

PhD Supervisor : Ariane Deniset-Besseau, Maître de Conférences Paris-Saclay University ; <https://www.linkedin.com/in/ariane-deniset-besseau-1b409185/>

PhD co-supervisor : Guillaume Miquelard-Garnier, Professeur des Universités CNAM, <https://pimm.artsetmetiers.fr/user/136>

How to apply

Via email to A. Deniset-Besseau ariane.deniset@universite-paris-saclay.fr and G. Miquelard-Garnier guillaume.miquelardgarnier@lecnam.net : Please submit a CV including references, Masters degree (or equivalent) grades (and diploma if already acquired), and a letter of motivation.

References

- Dazzi, A., Mathurin, J., Leclere, P., Nickmilder, P., De Wolf, P., Wagner, M., Hu, Q., & Deniset-Besseau, A. (2024). Photothermal AFM-IR Depth Sensitivity: An Original Pathway to Tomographic Reconstruction. Analytical Chemistry. <https://doi.org/10.1021/ACS.ANALCHEM.4C01969>
- Dazzi, A., & Prater, C. B. (2017). AFM-IR: Technology and applications in nanoscale infrared spectroscopy and chemical imaging. Chemical Reviews, 117(7), 5146–5173. <https://doi.org/10.1021/acs.chemrev.6b00448>
- Grandi A. A.*, Guinault A., Peixinho J., Sollogoub C., Antkowiak A., Neukirch S., Miquelard-Garnier G.*, “Young’s modulus of multilayer polymer films: the role of the interfaces”, *Soft Matter*, **2025**, 21, 4334-4341. DOI: 10.1039/D5SM00175G
- Dmochowska A., Peixinho J.*, Sollogoub C., Miquelard-Garnier G.*, “Extensional Viscosity of Immiscible Polymer Multi-Nanolayer Films: Signature of the Interphase”, *Macromolecules*, **2023**, 56 (16), 6222-6231. DOI: 10.1021/acs.macromol.3c00288