PhD vacancy (36 months)

Effects of nanoplastics on mammary tumorigenesis and its progression: a multi-scale physicochemical and oncobiological investigation

Project acronym	ONCOPLAST
Type	36-month PhD scholarship
Start Date	October 1st, 2026 (expected)
Location	Université de Lorraine-CNRS Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC, UMR 7360 CNRS), Research Group PhySI (Physicochimie et réactivités des Surfaces et Interfaces), Vandoeuvre-lès-Nancy, FRANCE & Centre de Recherche en Automatique de Nancy (CRAN, UMR 7039 CNRS), Research Group BioSiS (Biopsies Liquides et Optimisation Thérapeutiques), Université de Lorraine, Nancy, FRANCE
Webpage	https://liec.univ-lorraine.fr/ https://www.cran.univ-lorraine.fr/

Context

Breast cancer is the leading cause of cancer-related mortality among women in France, with over 60,000 new cases and 12,000 deaths recorded annually (INCa, 2023). While genetic risk factors are now well-characterized, understanding the contribution of environmental factors has become an urgent priority. In parallel, the ubiquitous contamination of ecosystems and the human body by plastic particles represents one of the most pressing environmental crises of our time. Plastic macro-waste degradation now infiltrates the human exposome through micro- and nanoplastic particles (NPPs), raising concerns about their potential role as environmental co-factors or catalysts of chronic diseases, including cancer.

The scientific community has established that plastic particles are not inert pollutants. They can induce cytotoxicity, oxidative stress, and chronic inflammation — three foundational pillars of carcinogenesis. Recent studies have demonstrated that polystyrene nanoplastics are significantly absorbed by human mammary epithelial cells, affecting their proliferation and migratory capacity. More alarmingly, exposure to polypropylene microplastics appears to alter gene expression patterns related to the cell cycle and promote the emergence of metastatic characteristics in breast cancer cells. Despite these advances, the specific role of nanoplastic particles as potential triggers of the metastatic cascade in mammary tissue remains largely unexplored.

This critical knowledge gap is further compounded by methodological limitations in existing studies: current exposure models are often overly simplistic (single-polymer particle, short-term) and lack adequate characterization of NPPs dynamics in biological media. The ONCOPLAST project, funded by the **CNRS Mission pour les Initiatives Transverses et Interdisciplinaires** (MITI) was conceived to address these shortcomings by analyzing the potential causal link between the physicochemical complexity of the nanoplastic exposome and mammary tumorigenesis — from tumor initiation to metastatic progression. This research is anchored in the One Health vision, which recognizes the deep interdependence between environmental pollution and human health.

Project Description

The ONCOPLAST project investigates the oncogenic effects of nanoplastics (NPPs, diameter < 100 nm) on human mammary cells, at the interface between colloidal physical chemistry and cancer cell biology. The central aim is to evidence causal links, if any, between the physicochemical complexity of the nanoplastic exposome — polymer composition, particle surface functionality, particle hetero-aggregation state — and mammary tumorigenesis, including the triggering of the Epithelial-to-Mesenchymal Transition (EMT). The PhD research program is structured around two integrated Axes:

Axis 1: Colloidal Physical Chemistry of the Nanoplastic Exposome

A mechanistic interpretation of NPPs-induced biological effects requires prior quantitative knowledge of their physicochemical behaviour in biologically relevant media. This axis is dedicated to the characterization of single-polymer and multi-polymer NPPs suspensions — comprising polyethylene (PE), polystyrene (PS), and polypropylene (PP) — under realistic exposome conditions. The candidate will quantify homo- and heteroaggregation kinetics and sedimentation dynamics in biological fluids by dynamic light scattering (DLS) and laser granulometry, alongside particle surface properties including electrokinetic charge, hydrophobicity/hydrophilicity balance, and surface chemical composition (FTIR). These parameters collectively govern the effective NPPs dose delivered to the adherent cell monolayer and condition the amplitude of the biological responses investigated in Axis 2.

Axis 2: Phenotypic, Functional, and Molecular Responses of Mammary Cells to NPPs Cocktails

Building on Axis 1, this second axis deciphers how NPPs mixture complexity modulates the malignant potential of three complementary mammary cell models: healthy MCF-10A epithelial cells, non-invasive MCF-7, and highly invasive MDA-MB-231 cells. A macroscopic phenotypic screening — encompassing proliferation, cell death, senescence, and migration/invasion assays across early, acute, and chronic exposure kinetics — will identify the most biologically relevant conditions for higher-resolution investigations. At the subcellular scale, fluorescence-based Confocal Laser Scanning Microscopy (CLSM) and spectral Fluorescence Lifetime Imaging Microscopy (FLIM) will enable the mapping of intracellular distribution of NPPs clusters, selected stress parameters and EMT markers. Finally, transcriptomic analyses will establish the molecular signatures of NPPs exposure and identify the signalling pathways driving EMT induction, providing causal evidence linking nanoplastic contamination to mammary tumorigenesis.

Role of the PhD Candidate

The doctoral student will act as the operational keystone of ONCOPLAST, bridging the complementary expertise of the LIEC and the CRAN. Working within a collaborative consortium, the candidate will benefit from an environment of active daily support from researchers and technical staff across both laboratories.

With a solid background in cell biology, the candidate will take the lead in phenotypic screening and identification of critical exposure conditions in Axis 2, and will conduct the transcriptomic analyses necessary to validate the molecular signatures of tumor progression. Alongside this biological expertise, the candidate will receive a comprehensive training in photonic techniques, progressively mastering routine Confocal Laser Scanning Microscopy (CLSM) and acquiring proficiency in spectral Fluorescence Lifetime Imaging Microscopy (FLIM) — a technique that provides a biophysical signature of fluorescence sources and their microenvironment.

The candidate will also be introduced to key physicochemical characterization experiments (Axis 1) through targeted training sessions within the LIEC team. This cross-disciplinary immersion will equip the doctoral student with an integrated vision of the project — from the characterization of colloidal interfaces to the mechanisms of the metastatic cascade — and will represent a decisive asset for a future career in academic research or industrial R&D.

Selection Criteria

- **Background:** Master's degree (or equivalent) in Cell Biology, Oncology, Biophysics, Biophysical Chemistry.
- **Technical Skills:** Knowledge of cell culture, fluorescence microscopy, and/or molecular biology techniques.
- **Language**: Very good written and oral communication skills in English are required. Knowledge of French is not mandatory.
- **Personal Qualities**: Autonomy, strong organizational skills, scientific curiosity, and an appetite for highly interdisciplinary research at the interface of chemistry and biology.

Strong added values to the application include: experience with fluorescence-based imaging techniques (CLSM/FLIM), competence in image processing (FIJI, etc.), and/or familiarity with bioinformatics tools for transcriptomic data analysis.

Scientific Environment of the PhD Candidate

The successful candidate will join leading multidisciplinary teams at the Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC, UMR 7360 CNRS – Université de Lorraine, Vandoeuvre-lès-Nancy) and the Centre de Recherche en Automatique de Nancy (CRAN, UMR 7039 CNRS – Université de Lorraine, Nancy).

The LIEC offers internationally recognized expertise across environmental physical chemistry, biophysics, and photonic imaging. The project will make extensive use of state-of-the-art confocal laser scanning microscopy and spectral Fluorescence Lifetime Imaging Microscopy facilities hosted by the DIESE imaging platform, alongside colloidal physical-chemistry techniques and a full suite of cell biology infrastructure.

The CRAN – BioSiS team brings internationally recognized expertise in cancer cell biology, and molecular oncology. The project will draw extensively on the team's established infrastructure for cell culture, phenotypic and functional assays (migration/invasion platforms), and transcriptomic analyses (RNAseq, RTqPCR arrays), providing the full biological toolkit required to decode the oncogenic signatures induced by nanoplastic exposure.

The ONCOPLAST project creates a unique consortium between LIEC and CRAN fusing expertise in colloidal physical chemistry, advanced photonics, and molecular oncology. The candidate will be actively supervised by researchers and engineers from complementary scientific horizons, ensuring a rich and rigorous interdisciplinary training environment.

The successful PhD candidate will be primarily based at the CRAN (Nancy), with regular and extensive stays at the LIEC (Vandoeuvre-lès-Nancy) for physicochemical characterisation and advanced photonic imaging experiments. Both sites are located within a 15-minute walk from each other.

Candidate Education / Experience

The following profiles are eligible and encouraged to apply:

- Master's degree in Cell Biology, Oncobiology, or Molecular Biology with interest in biophysical techniques.
- Master's degree in Biophysics or Biophysical Chemistry with experience in cell biology.
- Candidates from Engineering Schools in biology, biotechnology, biochemistry and/or biophysics are also eligible for the PhD position.
- Knowledge of physical chemistry and/or numerical programming (Python, MATLAB, FORTRAN, etc.) and image processing software (FIJI, etc.) would be a strong asset.

Remuneration

ca. 2,300 € (gross) / month (3-year contract).

Applications to Submit

Candidates are requested to submit a complete written application comprising:

1. A cover letter explicitly addressing one or several of the selection criteria set out above and highlighting your strengths and motivations for this PhD position (max. ~2000 words).
2. A full curriculum vitae.
3. Recommendation letters from at least two referees, including their contact details (email and phone) and professional positions.
4. Master 2 or final-year Engineering School transcripts of records.

Supervisors of the Doctoral Fellowship

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Candidates must submit their application through the PORTAIL EMPLOI CNRS platform https://emploi.cnrs.fr/ before June 10th, 2026.
(the platform will open on ~mid-april 2026 for this PhD offer)

Candidate may contact Jérôme F.L. Duval and Stéphanie Grandemange for information or any other difficulties encountered during submission of the application.

Keywords: *Oncology, Nanoplastics, Colloidal Physical Chemistry, Biophysics, High-Resolution Microscopy, Epithelial-to-Mesenchymal Transition, Breast Cancer, One Health.*