

## JOB OFFER

### PhD thesis funded by ANR – ICCF (Photochemistry Team – POPPI group, Université Clermont Auvergne)

#### Context

**ANR project “3Durable” (2024-2028)** brings together three French research laboratories: the Laboratory of Macromolecular Photochemistry and Engineering (LPIM, Mulhouse), the Institute of Physics and Chemistry of Materials of Strasbourg (IPCMS, Reims) and the POLymers, Photochemistry, Properties and Interfaces group from the Institute of Chemistry of Clermont-Ferrand (POPPI, Clermont-Ferrand). This project aims to understand the **photodegradation of photopolymers used in the field of 3D printing, with the goal of improving their durability.**

**3D printing** is a rapidly growing technique able to produce on-demand different kinds of objects, especially to replace damaged pieces. This technology was originally based on **thermal methods** (laser sintering, Fused Deposition Modeling...), but suffers from **limitations** such as energy consumption, production time or lack of spatio-temporal control. **Photochemical methods** are then increasingly used (stereolithography, Digital Light Processing or even Volumetric Additive Manufacturing) because they **strongly reduce these drawbacks.**

Within this framework, the POPPI group proposes a PhD project about the **photodegradation and the stabilization of these photopolymers.** Indeed, all polymers are prone to **degradation** under **environmental stress factors** such as light or heat. In presence of oxygen, a **chain radical mechanism** takes place and leads to a change in the chemical structure of the polymer, its macromolecular architecture and, *in fine*, its use properties. The main goal of this PhD project is then to **understand the photooxidation mechanism of these materials**, especially when they are prepared by additive manufacturing (*i.e.* layer by layer). This will enable to **develop stabilization strategies** allowing an efficient photopolymerization and a good durability.

The research methodology adopted in this PhD project will be based on the **multiscale analysis of the photoageing** developed in POPPI group. It consists in studying the consequences of photoageing on the **chemical structure of the polymer** (formation of oxidation products), the **macromolecular architecture** (chain scissions and/or crosslinking) and the **properties of the material** (mechanical, thermal, optical, barrier...). The research work will be performed in close collaboration with the other laboratories of the consortium, especially the non-permanent staff devoted to the project (PhD student in LPIM, post-doctoral researcher in IPCMS).

The recruited student will be in charge of the **accelerated artificial and natural photoageing** of the samples supplied by the partners, as well as their multiscale analysis with **several experimental techniques** available in ICCF and the partners (FTIR and UV-visible spectroscopies, SEC, rheology, DMTA, DSC, oxygen permeameter, AFM...). Relying on a bibliographic work, he/she will be able to **elucidate the photoageing mechanisms** of these materials and **propose relevant stabilization strategies.**

#### Organization

The PhD candidate will perform his/her research work in the ICCF (Clermont-Ferrand, France). Occasional trips to the partners will be planned.

#### Profile

- People holding a Master or an Engineer diploma in Material Science or Physico-Chemistry with knowledge about polymers and, if possible, their durability.
- Knowledge about basic characterization techniques of polymers (FTIR and UV-visible spectroscopies, DSC, chromatography...).



**POPPI**

- Fluent in English (written and oral). Autonomous, proactive, with organization and editorial skills, dynamism, intellectual curiosity, experimental rigor, good relationship, taste for research.

**Contract type:** ANR (36 months)

**Location:** Clermont-Ferrand /ICCF

**Gross salary:** around 2300 €/month

**Experience:** Master 2 or Engineer school

**Start of the contact:** end of 2024-beginning of 2025

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