Doctoral thesis 36 months, starting october 2025.

Mines Paris, Centre de Mise en Forme des Matériaux (CEMEF) Sophia *Antipolis, France*

"Impact of the use of recycled carbon fibers on the mechanical behavior and lifetime of thermoplastic composites."

Context: "L'Accord de Paris" aims to reduce emissions by 45% by 2030 and achieve net-zero emissions by 2050. To meet these targets, new concepts for high-performance, low-impact materials must be developed for terrestrial, maritime, rail, and air transportation. Composite materials, known for their exceptional performance, are considered a crucial element in eco-design and decarbonization efforts. Achieving these goals will require the use of low-emission materials, with recycled materials emerging as a clear choice [1]. Current technologies for composite recovery enable the recovery of chopped fibers. As such, the challenge of composite recycling and the reuse of recycled fibers partly lies in creating reinforcements made from more efficient secondary raw materials.

The project will be carried out as part of the "Lionel Fourment" Chair program proposed by CEMEF Mines Paris, in close collaboration with IPC (Industrial Technical Center for Plastics and Composites). This chair program, titled "CYCLADES" (reCYcling Composites and poLymers: Advanced processes, Durability, and numErical Simulation/artificial intelligence), primarily aims to understand the impact of incorporating recycled raw materials on the behavior of polymer or composite materials. The project described here focuses on the relationship between material processes, microstructure development, and final properties. The composites studied will consist of a poly(phenylene sulfide) (PPS) thermoplastic resin, reinforced with carbon fibers. Two types of recycled carbon fibers will be examined: fibers obtained through solvolysis and those obtained via pyrolysis.

Keywords : Polymer Composite Recycling, Mechanical properties, Durability

Topic description: Doctoral research will address the following objectives:

1) Understand the impact of recycling carbon fibers through solvolysis and pyrolysis on the quality of their impregnation, the presence of surface residue, their dimensions, and their mechanical properties,
2) Describe the microstructural and viscoelastic state of the PPS matrix in the presence of virgin or recycled fibers,
3) Investigate the thermomechanical behavior of composites with virgin or recycled reinforcement through tensile and creep tests at controlled temperatures and deformation rates,
4) Characterize the fatigue lifetime of these composites to assess the impact of reusing carbon fibers on the fatigue behavior of composites and propose a fatigue criterion,
5) Study the relevance of the selected fatigue criterion by applying it in post-processing of fatigue simulation for composite specimens.

The proposed scientific strategy will rely on an extensive experimental platform, equipped with analysis tools such as: X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA), and X-ray diffraction (WAXS and SAXS). Mechanical tests (fatigue, creep) combined with local measurements of strain and temperature fields, as well as melt-based shaping processes (thermocompression), will also be used.

Profile and Skills: The selected candidate must hold an engineering degree or a Master's degree (Master 2) in polymer materials science and possess strong expertise in physics and mechanics of polymers in the solid state. The research, which is application-oriented, will require a keen interest in experimental approaches. Experimental rigor, along with strong synthesis and communication skills, will be essential.

Duration: 36 months, starting in october 2025.

Approximate gross monthly salary: ~2300€ brut/month

Location: CEMEF, Mines Paris, Sophia-Antipolis (06), France (https://www.cemef.minesparis.psl.eu).

Research team: Surfaces and Polymers (https://www.cemef.minesparis.psl.eu/presentation/equipe-sp/)

Applications: Applications should be sent to the supervisors listed below and must include: a CV, a cover letter, and the contact details of two referees to recommend the candidate.

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[1] R. Agogué, W. Meddeb, M. Glais, L. Ainé, B. Courtemanche, P. Madec, F. Ruch, A. Zimmermann, T. Le Brun, A. Miller, J.-C. Fontanier Guide pour le recyclage et l'écoconception des composites – rapport Technique, ADEME, 2022