

PhD Thesis Offer

Experimental and numerical study of the interphase properties of plant fibre/lignin-epoxy composites using a micromechanical approach

Description of the RE-Fibre project:

RE-Fibre is a Doctoral Network funded by Marie Skłodowska-Curie Actions (MSCA-DN) that aims to revolutionize Bio-fibre composite landscape by designing high-performance, fully renewable, and recyclable wood and plant fibre materials. RE-Fibre will train 11 Doctoral Candidates (DCs) with an entrepreneurial and sustainability-mindset in the disciplines of green/lignin chemistry, new biobased materials, and environmental systems science.

The DCs will build on ground-breaking findings being generated at the RE-Fibre consortium, to enable the development of fully recyclable functional biobased composites with properties on par with fossil-based counterparts. They will gain competencies, not only in a breakthrough scientific field but also in interdisciplinary and interpersonal skills. Additionally, they will expand their network and gain experience through participating in secondments (research stays at a site of an academic or industrial partner). Finally, DCs will learn the best practices by developing online research and training tools, enabling them to work and collaborate across academic and industrial sectors. RE-Fibre training will contribute to DCs employability as future leaders, while supporting the green transition and a sustainable circular economy in Europe.

Description of the PhD position:

This PhD Thesis offer is part of the RE-Fibre project (DC8). The main ambition is to develop high strength, lightweight, fully bio-based and recyclable composites using recyclable lignin-derived epoxies and polyurethanes and plant fibre reinforcements (flax and hemp). To reach the requirements for the industrial application of composites, it is necessary to better understand the interaction of epoxy resins with plant fibres and the physicochemical phenomena that take place in the interface region during plant fibre impregnation and epoxy curing.

The main objectives are:

- (1) Characterise the interface region between plant fibre and lignin based epoxy resin and map the nonuniform mechanical properties in the interphase material
- (2) Shed light on the physicochemical phenomena that take place in the interface region during plant fibre impregnation and epoxy curing
- (3) Evaluate the influence of non-uniform mechanical properties using micromechanical models and numerical simulation

Keywords: Plant fibre composites, lignin-derived recyclable polymer, fibre/matrix interface, micromechanics

Description of the host Institution:

UMLP University:

The Université Marie et Louis Pasteur (UMLP) is a French university with the status of an experimental public institution (EPE), established on December 1, 2024. As of January 1, 2025, it succeeds the University of Franche-Comté (<https://www.univ-fcomte.fr/>) and the University Bourgogne-Franche-Comté (<https://www.ubfc.fr/en/>), consolidating their academic and research activities under a unified structure.

UMLP contributes in the RE-Fibre project by leveraging its expertise in applied mechanics and advanced materials science to develop and evaluate bio-based composites. The MAT'ECO team (<https://www.femto-st.fr/en/Research-departments/APPLIED-MECHANICS/Research-groups/Mateco-team>), led by Dr. Vincent Placet from the Department of Applied Mechanics, focuses on prototyping and demonstrating innovative composite materials derived from plant fibres. MAT'ECO's work emphasizes the mechanical characterization, modelling, and testing of these materials under various environmental conditions to ensure their durability, sustainability, and alignment with industry performance requirements. As part of the RE-Fibre project, UMLP is actively involved in Work Package 3 (WP3), titled "Lignin Reassembly into Scaffolds and Material Fabrication."

In particular, UMLP contributes to the tasks focused on developing novel fabrication platforms based on cellulosic scaffolds and conducting an in-depth analysis of the interphase region to optimize the performance and integration of bio-based materials, and to the supervision of DCs 8 and 9.

FEMTO-ST Institute (<https://www.femto-st.fr/en>):

The FEMTO-ST Institute “Franche-Comté Electronics Mechanics Thermal Science and Optics – Sciences and Technologies” is a joint research institution. It is the largest public research laboratory in the Bourgogne-Franche-Comté region, located in eastern France, next to Switzerland and Germany. It comprises 7 scientific departments with approximately 750 staff members (PhD students, postdoctoral fellows, technicians, engineers, administrative staff, researchers and professors).

Supervision:

Main supervisor: Dr. Vincent PLACET (UMLP), **Co-Supervisor:** Dr. Florian BOUTENEL (UMLP)

Co-Tutor: Dr. Peter DEUSS (University of Groningen, Netherlands)

Industrial Supervisor: Dr. Marion FREY (BComp, Fribourg, Switzerland)

Work location(s):

Main location: FEMTO-ST Institute, Department of Applied Mechanics, Besançon, France

The doctoral candidate will be enrolled at the Doctoral School “Physical Sciences for Engineering and Microtechnologies” (<https://spim.ubfc.fr/en/>).

Secondments:

- ETH Zurich, Switzerland (4 months) application of developed characterization methods on wood-based composites (Pr. Ingo BURGERT)
- BComp, Fribourg, Switzerland (6 months) investigate and understand requirements for fibre-applications (Dr. Marion FREY)

Starting date: June 2025

Funding:

Horizon Europe MSCA - DN (RE-Fibre project)

Marie Curie Grant Agreement Number: 101168684

Marie Skłodowska-Curie DCs are paid a competitive gross Living Allowance of 3,400 €/month, adjusted for their host country, a Mobility Allowance of 600 €/month and, for researchers who have a family, a Family Allowance of 660 €/month. All amounts are subject to deductions and taxes. Family is defined as persons linked to the researcher by (i) marriage, or (ii) a relationship with equivalent status to a marriage recognised by the national legislation of the country of the beneficiary or of nationality of the researcher, or (iii) dependent children who are actually being maintained by the researcher.

Type of contract:

Temporary, Full-time

Profile requirements

- Master’s degree in Mechanical Engineering, Materials Science, Advanced Composites, Bio-based Materials, Wood Sciences
- Knowledge and skills in composite materials (manufacturing, testing and modelling), polymer chemistry.
- Software: proficient with Matlab and FEM
- Curious, self-motivated, hard-worker
- English: fluent reading, writing and speaking with ease.

Application procedure

Where to apply: <https://refibre-dn.eu/>

Deadline: 28 February 2025 – 17:00 CET

There are strict eligibility requirements for the DC positions in MSCA-Doctoral Networks (DNs). Please ensure to be qualified before applying, as ineligible candidates cannot be considered.

- Admission to the program is open to applicants who hold a 2nd Level Master Degree (120 ECTS + 180 ECTS in a bachelor degree) or a Single Cycle Degree (minimum 300 ECTS), or a comparable university degree (Second Cycle qualification), as required by the partner universities for admission to doctoral studies.
- At the time of recruitment applicants must not have been awarded a doctorate.
- **At the time of recruitment applicants must not have resided or carried out their main activity (work, studies, etc.) in the country of their host organization for more than 12 months in the 3 years immediately before their recruitment date.** Compulsory national service and/or short stays such as holidays and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.
- Applicant must be able to communicate fluently in English (at least B2-level speaking and writing). The Supervisory Board will pay special attention to respect gender balance.

Selection process

RE-Fibre will adopt the principles of the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers promoting open, merit-based and transparent recruitment and attractive working and employment conditions.

The two-step procedure for applicants' selection is based on assessment of the documents attached to the application form and on an interview (videoconference) to those applicants who have passed the first-step selection. Shortlisted applicants will be informed of the interview process within three weeks from the deadline for applications.

Additional comments

Applicants can apply for up to 3 PhD projects, indicating the order of preference. All applications will have to be written in English and will be checked for eligibility. Ineligible or incomplete applications will not be considered. Applications must be submitted through the RE-Fibre website (<https://refibre-dn.eu/>) from 01.02.2025 at 17:00 Central European Time to 28.02.2025 at 17:00 Central European Time. Applications coming through different channels than the project website (e.g. sent by email) will not be considered.

Applicants are required to fill in the Application form on the website and submit the following documents by uploading them as PDF files:

- Detailed Curriculum Vitae (Europass format – with added List of publications, participation in funded research projects, other qualifications, if any, must be included)
- Certified copy of Academic Degree/s in original language along with a certified translation into English, and/or Diploma Supplement (if applicable)
- Certified copies of official Academic Transcripts relating to all academic courses taken to earn every degree (bachelor/master or equivalent), translated into English, and corresponding grade point average
- Copy of passport (or, for EU citizens, equivalent ID document)

Additionally, to complete your application, please send the filled Mobility Rule template to applications@refibre-dn.eu. Finally, two recommendation letters (prepared using a template) must be sent directly by the referees to applications@refibre-dn.eu, with the name of the applicant in the subject line until the application deadline. Recommendation letter template and Mobility Rule template can be downloaded on the confirmation page after submitting the application form and are included in the conformation mail.

Failure to submit any of the above documents or lack of any of the required reference letters implies exclusion from the RE-Fibre recruitment procedure. For more information, please contact us through the Contact form on the RE-Fibre website. Data of the applicants will be shared within the Consortium for recruitment purposes only. All data provided by the applicants are processed solely for the purpose of the RE-Fibre call for applicants.

The application deadline may be extended if not enough applications are received. Information about a possible extension will be published on the project website and other communication channels.

Website for additional job details

<https://refibre-dn.eu/>

Recent Team's Publications:

- Jason Govilas, Anouk Chevallier, Wajih Akleh, Johnny Beaugrand, Cédric Clévy, Vincent Placet. Mechanical behavior and apparent stiffness of flax, hemp and nettle fibers under single fiber transverse compression tests. Composites Part A: Applied Science and Manufacturing, Volume 185, 2024, 108321, <https://doi.org/10.1016/j.compositesa.2024.108321>

- Xianyuan Wu, Peter Hartmann, Dimitri Berne, Mario De bruyn, Florian Cuminet, Zhiwen Wang, Johannes Matthias Zechner, Adrian Daniel Boese, Vincent Placet, Sylvain Caillol, Katalin Barta. Closed-loop recyclability of a biomass-derived epoxy-amine thermoset by methanolysis. *Science* 2024:384, 6692, <https://doi.org/10.1126/science.adj9989>
- Kuntawit Witthayolankowit, Thanya Rakkijakan, Rabia Ayub, Ivan Kumaniaev, Sylvie Pourchet, Gilles Boni, Ponnapat Watjanatepin, Hanie Zarafshani, Xavier Gabrion, Anouk Chevallier, Nhan Vo, Aart Van Vuure, Patrick Balaguer, Karel Van Acker, Joseph S.M. Samec, Vincent Placet. Use of a fully biobased and non-reprotoxic epoxy polymer and woven hemp fabric to prepare environmentally friendly composite materials with excellent physical properties. *Composites Part B: Engineering*, Volume 258, 2023, 110692, <https://doi.org/10.1016/j.compositesb.2023.110692>
- Taiqu Liu, Yves Gaillard, Pauline Butaud, Vincent Placet, Morvan Ouisse. In situ damping identification of plant fiber composites using dynamic grid nanoindentation. *Composites Part A*, 2022, 107158. <https://doi.org/10.1016/j.compositesa.2022.107158>