PhD project
Biocarbons (Biochars) carbonisation, graphitisation, multiscale characterisation and energy storage performances

School: IMT Mines Albi, France
Doctoral school: Mechanics, Energetics, Civil & Process Engineering (MEGEP), University of Toulouse)
Research laboratory: RAPSODEE – IMT Mines Albi – UMR CNRS 5302
Supervisor: Prof Ange Nzihou
Location: Albi (RAPSODEE CNRS-IMT Mines Albi) with stays in international partner' labs
Financial support: ERC (European Research Council) Advanced Grant
Collaboration: Collaboration with partners in France, UK, Germany, and USA
Starting date: September or October 2025
Application deadline: June 25, 2025

Offer description:
This work is part of an ERC (European Research Council) Advanced Grant project. The ERC is a European funding organisation that supports ambitious and innovative research projects through competitive grants, as part of the EU's Horizon Europe programme.

The project aims at the synthesis of biocarbon-based composites for energy storage.
An ongoing study is focused on the selection of biomass feedstocks, their characterisation and on pyrolysis to produce biocarbon composites. As part of this ERC work and in parallel with other ongoing studies in our research group, this PhD work will be dedicated to the synthesis (standard and concentrated solar processes) of ordered biocarbon using carbonisation and graphitisation processes, and they application in energy storage. Multiscale structure (micro, nano and atomic) assessment will be performed using various standard chemical and physical techniques including particle size distribution and shape, elemental and chemical composition, specific surface area as well as thermochemical and thermomechanical parameters from thermogravimetric and differential scanning calorimetry (TGA-DSC), and thermomechanical analysis (TMA).
Particular attention will be paid to its multi-scale (micro, nano and atomic) chemical, mechanical and structural transformations. It is expected to probe the changes in biocarbon nanostructure, aromaticity and/or degree of aromatic condensation, crystalline graphitic domains and investigate how this evolution is impacted by the inclusion of inorganic elements. Raman spectroscopy, X-ray diffraction, transmission electron macroscopy, and X-Ray photon spectroscopy among other complementary techniques will be used to this end. The study

should investigate the relation between carbon structure, thermomechanical stability, and conductivity of the biocarbon and the impact of these properties on storage performances. These properties and performances will be correlated with the feedstocks, production process and application in energy storage. A sustainability assessment approach will be developed for the biocarbon value chain.

Keywords:
Biocarbon, carbonisation and graphitisation, standard and advanced characterisation chemical, thermophysical and thermoelectrical properties, Energy storage, sustainability indicator calculations.

Skills:

It is expected that the candidate holds a Master degree in chemical, or material engineering, or in material science, or solid-state physics with initial background on solid characterisation. Initial experience in some of the following techniques, XRD, XPS, TGA-DSC, N2 sorption, SEM-EDS, HR-TEM, Raman spectroscopy, synchrotron will be much appreciated.

Working environment:

The candidate will work at the RAPSODEE research laboratory at IMT Mines Albi in France to produce materials using conventional heating, and for their characterisation. Some of the experiments (concentrated solar graphitisation and energy storage) as well as advanced characterisation will be carried out in PROMES CNRS laboratory (Odeillo, France) and in partners laboratories in USA, Germany, or UK. It is expected that the PhD student visits some of those places to perform part of the PhD work.

Application:
Please send your CV, cover letter and 1 or 2 recommendation letters to
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