

## Open PhD position

### Title: “Preparation/characterization of activated carbon for CO<sub>2</sub> gas adsorption and separation”

#### Keywords

CO<sub>2</sub> capture, adsorbents, activated carbon, gas, regeneration

#### Objectives

The main aim of this project is to synthesize efficient porous carbon materials for CO<sub>2</sub> separation. Other objectives are: (i) to increase the knowledge in science applicable CO<sub>2</sub> separation technology by adsorption and; (ii) to provide methods and guidelines for the preparation/modification of these materials.

#### Position and tasks

CATALPA is a 4 years PEPR research project, funded by the French “National Research Agency” (“ANR”) program”. The CATALPA project entitled « CO<sub>2</sub> cApTure At Low or decarbonized energy PenAlty », involves 5 academic partners, and one industrial collaborators (IFPEN). The IJL and EDYTEM Laboratories are two partners for the Work Package WP 1: “Innovative separative media for low-carbon footprint CO<sub>2</sub> capture processes”.

The work dedicated to WP1 will consist in preparing appropriate activated carbon with ultra-micropores (pore diameters < 0.7 nm) and a surface chemistry enriched in electron donors (N, S, F, etc) able to selectively physisorb/desorb of CO<sub>2</sub> from a gas mixture also containing CH<sub>4</sub> and/or N<sub>2</sub> and other minority components over a large pressure range (up to 20-30 bar).

Activated carbons and activated carbons-graphene oxide materials will be prepared by activating naturally N-rich or S-rich biomass (chitosan, keratine, etc..) or a synthetic precursor (including graphene oxide) by a thermochemical activation (using NH<sub>3</sub> as a doping agent and various activating agents such as steam, KOH, NaOH, etc.). The application of post-thermal treatments (800°C-1500°C) will allow to tailor the pore size distribution in order to enhance adsorption selectivity. Additionally, the preparation of activated carbons by loading with supported metal oxides and or the saturation of the activated carbons with solvents such as ionic liquids. Green chemistry principles will be followed as far as it is possible.

The elaborated activated carbons will be characterized to determine their textural properties (determination of the micro/meso/macro porosity) and also their surface chemistry properties (oxygenated and nitrogenated groups, composition by elemental analysis, ICP analysis of the ashes, and XPS). The textural characteristics (porosity) of the materials will be determined by adsorption-desorption of N<sub>2</sub> at -196°C, CO<sub>2</sub> at 0°C, Ar at -186°C and/or H<sub>2</sub> at -196°C, depending of the solid one gas or two gases will be used to obtain precise textural characterization and pore size distributions. Chemical and structural characterization will be also conducted including elemental analysis, FTIR, PXRD, SEM, and TGA. The adsorption isotherms for pure gases (CH<sub>4</sub>, CO<sub>2</sub>) and their mixtures will be determined and their adsorption enthalpies evaluated.

Reusability and breakthrough curves will be measured in a multicomponent adsorption unit at IJL. Reusability will be addressed through repeated cycles of adsorption/desorption in the same small co-adsorption unit. The best ACs will be produced in larger amounts in order to pelletize them and test in a PSA/TSA unit equipped with two parallel columns already available at IJL. This will allow to optimize the material CO<sub>2</sub> separation efficiency and to better understand the adsorption properties in relation with its structure texture structure and surface chemistry characteristics

The Ph. D student will work on the WP1 tasks of the CATALPA project on two sites: EDYTEM laboratory at University Savoie Mont Blanc (Le Bourget du Lac site) and Institut Jean Lamour at University de Lorraine (Epinal site). The Ph. D student researcher will have to interact and collaborate with the partners implied in the CATALPA project, and present the results in progress meetings.

### Geographic Mobility

The position is open for a period of 36 months

Best starting date: September-December 2023

National mobility is required

### Profile

The candidate should have strong skills in materials chemistry, in adsorption phenomena onto solids, and characterization of porous materials. The candidate possesses a background in materials chemistry or chemistry-physics (Master or Engineer in materials science or chemistry). Good experience in the laboratory experimental work in chemical and analysis techniques is required. Knowledge in analytical chemistry will be positively considered.

The candidate is expected to produce independent and original research in the defined area, to be capable of working highly autonomous, to interact with the members of the group, to write progress reports, and to participate in dissemination activities (publications, workshop, conferences and progress meetings).

### Required documents for the application

- Short Curriculum Vitae and a covering letter showing your interest and especially addressing your professional project
- Recommendation letters.
- Scores and rank in the last formation

The selected candidates will be first interviewed by videoconference and then if possible interviewed at the host research unit.

### Contacts

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**Vanessa Fierro** (Research Prof.), **Vanessa.Fierro@univ-lorraine.fr** +33 (0)372 749 677

**Laurence Reinert** (Assistant Prof.), **Laurence.Reinert@univ-smb.fr** +33 (0)479 758 122

### Salary

Fixed Term contract 36 Months

Gross salary estimation 1975 € / months



## **Workplace**

EDYTEM, University Savoie Mont-Blanc, Le Bourget du Lac – Rhône-Alpes Auvergne – France  
Institut Jean Lamour, University of Lorraine Epinal – Région Grand Est – France

## **Employer**

### **University Savoie Mont-Blanc**

With 14 000 students, a rich variety of multidisciplinary education and 19 research laboratories internationally renowned, the University Savoie Mont-Blanc is a human-sized institution which combines proximity with its territories and a wide perspective on Europe and the world.

The campus sites at Le Bourget-du-Lac offers particularly attractive living and studying conditions, at the center of an exceptional environment, between lakes and mountains.

The aim of the University Savoie Mont Blanc is, on the one hand to develop international projects, joint award qualifications, and programs delivered in English, and on the other hand, wherever possible, to encourage mobility for students, lecturers and researchers as well as for administrative staff. Although present in 5 continents, with its 240 bilateral agreements, it has been able to take full advantage of its outstanding location on the borders of Switzerland and Italy to develop strong, special relationships with the higher education establishments of these two countries.

### **Laboratory Environment Dynamics and Territories of the Mountain (EDYTEM)**

With a truly interdisciplinary approach, EDYTEM looks at the environment in the widest sense (its climate, chemistry, biology and ecology as well as the social, economic and political aspects), studying archives, resources, changes and vulnerabilities and the players' terms of commitment. EDyTEM (Environnements, Dynamiques et Territoires de Montagne, UMR Université de Savoie Mont Blanc/CNRS 5204) and its « Matières » team are focused on green chemistry synthesis and biomass valorization processes, and particularly on the synthesis and characterization of porous activated carbon materials for environmental adsorption applications. Over the past decade more than 60 articles have been published in international scientific journal on porous carbon preparation and application, and more than 15 communications have been made in national and international research projects on carbon materials; more than 10 research contracts have been operated with private companies. More details are on the web site of "EDYTEM" (in French): <https://edytem.osug.fr/>

### **Institut Jean Lamour (IJL)**

The biosourced materials at Institut Jean Lamour (IJL , UMR 7198, Université de Lorraine CNRS) is specialized in porous materials for energy and environment. The two senior members of the team involved in the project, Vanessa Fierro (VF) and Alain Celzard (AC), are world-renowned experts in the area of gas separation by means of porous carbonaceous materials and in their synthesis, characterization and modeling: VF was awarded the 2020 CNRS silver medal and AC, a senior member of the Institut Universitaire de France, was the 2019 recipient together with VF of the Pettinos Award of the American Carbon Society. The experimental setups available at IJL include a Pressure/Temperature Swing Adsorption (PSA/TSA) unit equipped with a mass spectrometer and an in-line chromatograph for output analysis and a multicomponent adsorption device (to be purchased). This team is part of CarbBioLab (Laboratoire de carbones biosourcés), a common lab (2022-2026) with Groupe Bordet, which elaborates in France and markets high-added-value activated carbons from French woods.