

Ph.D. position in Biotechnology and Fluid Dynamics

Development of a millifluidic reactor for multistep continuous synthesis of bio-based styrenes derived from p-hydroxycinnamic acids

Context:

The increasing customer demand for natural antioxidants and flavors aligns with the emergence of new enzymatic tools that offer alternative ways to access healthier flavor compounds. Styrenes, such as 4-vinyl phenols, are particularly valuable products in the food, cosmetic, pharmaceutical, and chemical industries. Typically, they are obtained through the chemical decarboxylation of p-coumaric acid (p-CA) or ferulic acid (FA), which are p-hydroxycinnamic acids (p-HCAs), using metal catalysts under harsh conditions. However, this raises concerns about product safety and the generation of hazardous waste. Consequently, there is a growing research focus on the sustainable production of renewable 4-vinyl phenol from biomass.

The MilliStyrene project, funded by the ANR (Agence National de la Recherche), involves a consortium consisting of URD ABI from AgroParisTech, CRPP (Centre de Recherche Paul Pascal) located in Bordeaux, and the Chair of Biotechnology of CentraleSupélec. This project represents the initial endeavor to substantially decrease the cost of biobased 4-vinyl phenols by developing an innovative In-Stream Product Recovery (ISPR) compartmentalized millifluidic reactor for the enzymatic conversion of p-HCAs into 4-vinyl phenols.

Objectives:

As part of the MilliStyrene project, this Ph.D. thesis aims to develop a millifluidic reactor using a droplet-based experimental approach. The objective is to define potential reactor design (shape, size, flow rates, indexes length...), and to realize and test one or two candidate designs. This requires the development of a detection method for both p-HCAs and 4-vinyl phenols through their natural fluorescence, along with a numerical approach based on multiphase flow simulations coupled with products diffusion and reaction rates. The combination of experimental and numerical works will be utilized for testing and optimizing the miniaturized production. Lastly, based on the computational tools and the results gained by the candidate designs, the Ph.D. candidate will collaborate with the project partners to implement a scaled-up continuous millifluidic reactor.

Host Laboratory:

The thesis will be carried out in the Biotechnology chair of CentraleSupélec, University Paris-Saclay (<http://www.chaire-biotechnologie.centralesupelec.fr/>).

The Biotechnology Chair of CentraleSupélec, established in 2011 and located within the Bazancourt-Pomacle biorefinery (51), is structured around three thematic areas: i) Biosourced Materials, ii) Bioengineering, and iii) Process Engineering, all supported by an interdisciplinary modeling, instrumentation and visualization platform. It is one of the four groups hosted by the European Center for Biotechnology and Bioeconomy (CEBB).

The Biotechnology Chair of CentraleSupélec is affiliated with the Laboratory of Process Engineering and Materials (LGPM) located in Gif-sur-Yvette (91).

The Biotechnology Chair of CentraleSupélec was renewed in 2020, allowing for a substantial increase in its capabilities and to launch the microfluidic activities. The aim is to extensively utilize coupled modeling and micro-experimentation to scale up to an industrial level, with the objective of creating a digital twin of the biotechnology industry. The technical hall of CEBB houses a set of laboratory pilots conducive to validating this virtual approach through a pilot plant.

Funding:

The Ph.D. thesis is funded by ANR (Agence Nationale de la Recherche) and the Biotechnology chair.

The Salary is around 2100 € brut.

Candidate profile:

- Chemical or Mechanical Engineering degree or master's in fluid dynamics/mechanics
- Theoretical and/or practical knowledge of fluidic systems and optics
- Experience or at good motivation for a CFD simulation software like OpenFoam or Ansys Fluent
- Command of a programming language such as MATLAB or Python
- Knowledge of analytical chemistry would be a plus
- An interest in working at the biochemistry-microbiology/physics interface
- Rigorous, autonomous, and dynamic student

Location:

Biotechnology Chair (European Center for Biotechnology and Bioeconomy), 3 Rue des Rouges-Terres, Pomacle (51110), located 15 km from Reims, France.

Applications:

Applications (CV + motivation letter, academic transcripts) should be sent by email to:

Prof. Patrick Perré: patrick.perre@centralesupelec.fr

Dr. Hassan El Itawi: hassan.el-itawi@centralesupelec.fr