Master thesis proposal (5 to 6 month)

Pure cellulose dissolution and regeneration through a novel process involving cellulose oxidation – investigation of the dissolution and regeneration steps

Context

The increase in demand for textile fibers and growing concerns about the environmental impact of natural and synthetic sources are creating a need for renewable and low-impact alternatives. One promising solution is to regenerate cellulose fibers from paper pulp. Traditional methods, such as the viscose process, are effective but rely on toxic chemical reagents such as carbon disulfide. More recent technologies (such as Lyocell or Modal) use more environmentally friendly solvents, but involve complex, costly, and energy-intensive processes.

In 2020, LGP2 patented a novel process for cellulose dissolution and regeneration using only aqueous solvents (Lachenal, D., Hérisson, A., Carré, B., Zeno, E., Procédé de Solubilisation et de Régénération de la Cellulose, French Patent n° 2012561 Dec. 2, 2020). Pure cellulose is first oxidized by the periodate-chlorite sequence in order to introduce COOH groups while avoiding extended cellulose depolymerization. The carboxylated cellulose (DCC for dicarboxyl cellulose) is then dissolved in an aqueous sodium hydroxide solution and the resulting dope is regenerated into filament in acidic condition. The whole process requires (1) the selective oxidation of cellulose by the periodate-chlorite sequence and (2) the efficient DCC dissolution and regeneration.

This new process has been tested mainly on dissolving pulp, pure in cellulose. In all the studies previously conducted, the focus was made on the DCC properties (%COOH and IVL) to favor dissolution and regeneration. The composition of the dissolving solvent and regeneration bath was not really investigated although these process parameters are also key for the cellulose regeneration. Moreover, till to date, the regeneration was “hand-made” using a syringe, not in a continuous way. This internship aims (1) to look into the second phase of the process, i.e., dissolution and regeneration, to improve filament formation; and (2) to restart a spinning pilot to allow filament to be regenerated continuously.

Objectives

The intern will be responsible for the following tasks:

- Preparation of a batch of oxidized cellulose from dissolving pulp using the periodate-chlorite sequence (conditions for high COOH % and sufficient IVL will be taken from previous studies)
- Variation of the dissolution conditions (nature of the solvent, additives, temperature, time, agitation….) – dissolution yield measurement by gravimetry
- Variation of the regeneration conditions (nature of the solvent, temperature, additives, residence time…) – regeneration will be “hand-made” with a syringe or on a spinning equipment.
- Restart of a lab-scale equipment for continuous spinning
- Analysis of the regenerated filaments (optical measurements, IVL)

In parallel, a review on cellulose dissolution and regeneration optimal conditions will be done in order to choose the process parameters to be tested/varied.

Student profile

Student in Master 2 Chemistry, Materials or Process Engineering, looking for an internship in the research sector applied to industrial challenges. Pre-requisites in chemical engineering, analytical chemistry and lignocellulosic biomass are expected. The selected candidate will be able to demonstrate scientific curiosity, rigor, autonomy and dynamism, as well as team spirit and personal skills. Candidates should be fluent in French or English and have good writing and presentation skills.

Location and supervision

The internship will start in **February 2025 for a duration of 5 to 6 months**. The project will be conducted at LGP2, the Laboratory of process engineering for biorefinery, bio-based materials and functional printing, Grenoble, France (https://lgp2.grenoble-inp.fr/en), under the supervision of the BioChip senior researchers (Bastien Michel, Nathalie Marlin and Gérard Mortha). Internship allowance around 550 Euros/month.

How to apply?

Send your CV, a motivation letter, master transcript (marks) to Bastien Michel, bastien.michel@grenoble-inp.fr and Nathalie MARLIN, nathalie.marlin@grenoble-inp.fr – Deadline to apply: 15/11/2026