



A novel approach for production of micro/nanofibrillated cellulose (M/NFC)

1. Context:

Micro/Nanofibrillated Cellulose (M/NFC) have gained increasing attention for the production of new innovative materials due to their remarkable properties **(1)**. The defibrillation of M/NFC generally requires intensive and energy consuming treatments. The high cost of these extraction processes constitutes one of the main limitations of the M/NFCs broad utilization **(2)**.

Steam explosion (SteamEx) is one of the most valuable pre-treatment technologies for lignocellulosic biomass **(3)**. The effect of SteamEx on biomass combines a **chemical hydrolysis** of cellulose chains during the steam treatment and **defibration** during the explosive decompression. Steam explosion process is one of the dominant pre-treatments for bioethanol production from wood (using enzymatic methods and fermentation) but has been also previously described for the extraction of fibres and primarily micro-fibres from biomass **(4)**.

The objective of this study is to propose an innovative low-energy and environmentally friendly combinative process for the production of M/NFC from bleached Eucalyptus bark (EB) and Beech wood (BW). The main originality of the project is to compare produced M/NFCs with M/NFCs already produced from unbleached EB and BW.

The main goal is to study the effect of lignin on the properties of M/NFCs. Applications in the fields of packaging (films or nanopapers) and wood particleboard (tannins-based adhesives) will be considered in the project.

PhD student (Saad NADER) has demonstrated the possibility to produce M/NFCs from unbleached BW and EB. This study (funded by the LabEx Tec21 in Grenoble and labEx Arbre in Nancy) was made in collaboration between the LERMAB (Nancy) which has developed knowledge in the SteamEx treatment and the LGP2 (Grenoble) which has gained an expertise in the field of nanocelluloses.

2. Objectives:

The main objectives of this research project are:

- 1.** to study the production of fibres with different contents in lignin and the effects of the composition of the fibres on the fibrillation process and the quality of the M/NFCs. The lignin extracted using these processes will be characterized.
- 2.** to focus on two specific applications of the M/NFCs for which the relation between the end-use properties, the production process and the vegetal species used will be studied
 - Applications in the field of packaging will be considered. Films or nanopapers will be produced in controlled conditions by filtration of a M/NFC suspension followed by a

drying step. Density, tensile properties, water absorption, dimensional stability, O₂ permeability will be assessed more particularly.

- Applications in the field of wood innovative materials will also be examined. According to previous works (Saad NADER PhD) addition of M/NFCs to adhesive could be an effective method for increasing bonding strength.

Figure 1 Shows a method of production of bleached M/NFCs:

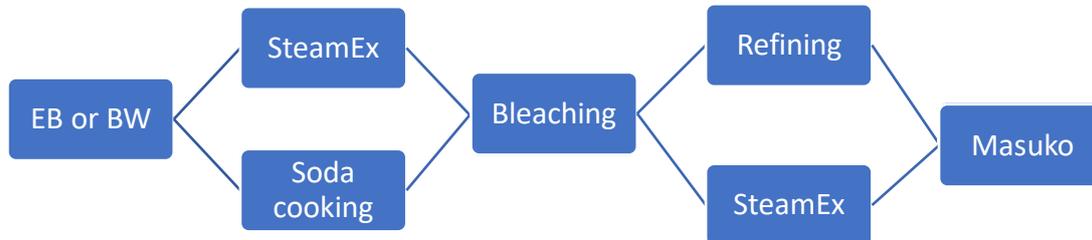


Figure 1: Proposed method for M/NFCs production

This study combining multiple aspects of an engineer project is dedicated to the development of new products and processes and requires multiple skills:

- Ability to handle characterisation tools
- Ability to analyse and synthesize a large amount of data
- Writing and interpersonal skills

Candidate profile: M2 student with good knowledge in processes and materials, good abilities for experimentation and good project management skills.

Duration of the contract: 6 months / Location: Grenoble (LGP2 laboratory), a visit in Nancy (LERMAB) will be scheduled.

To apply: resume, cover letter, reference letters and academic transcripts (from the last three years of study) should be sent to Saad NADER (saad.nader@lgp2.grenoble-inp.fr) and Evelyne MAURET (evelyne.mauret@lgp2.grenoble-inp.fr).

3. Bibliography:

1. Klemm, Dieter, Friederike Kramer, Sebastian Moritz, Tom Lindström, Mikael Ankerfors, Derek Gray, et Annie Dorris. 2011. « Nanocelluloses: A New Family of Nature-Based Materials ». *Angewandte Chemie International Edition* 50 (24): 5438-66. <https://doi.org/10.1002/anie.201001273>.
2. Nechyporchuk, Oleksandr, Mohamed Naceur Belgacem, et Julien Bras. 2016. « Production of Cellulose Nanofibrils: A Review of Recent Advances ». *Industrial Crops and Products* 93 (décembre): 2-25. <https://doi.org/10.1016/j.indcrop.2016.02.016>.
3. Kaar, W E, C V Gutierrez, et C M Kinoshita. 1995. « STEAM EXPLOSION OF SUGARCANE BAGASSE AS A PRETREATMENT FOR CONVERSION TO ETHANOL », 11.
4. Sauvageon, Thibaud, Jean-Michel Lavoie, et Nicolas Brosse. s. d. « Toward the Cottonization of Hemp Fibers by Steam Explosion – Part 1: Defibrillation and Morphological Characterization ». *Textile Research Journal*, 9.