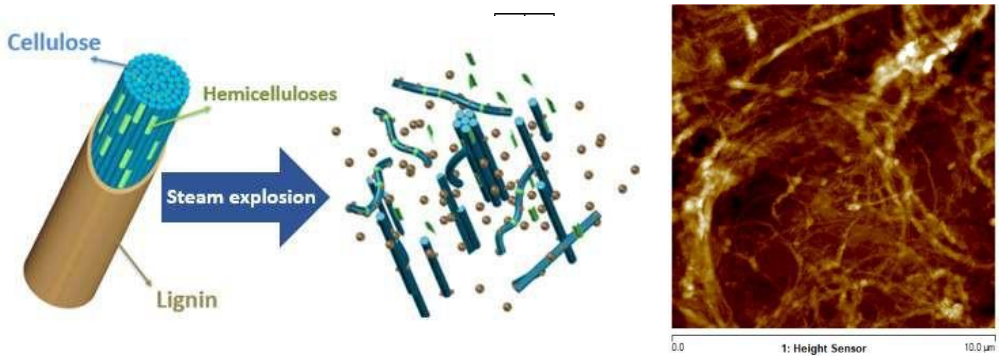
NanoSteamEx



Production of microfibrillated cellulose by a steam explosion process

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With the collaboration of:
Labex TEC21 (Grenoble) MAURET Evelyne (LGP2, UMR5518)

Work package: WP3

Context — Micro and Nano-Fibrillated Cellulose have gained an increasing attention due to their remarkable properties. Owing to their high specific surface area, NMFC can be used in different applications, i.e. in paper reinforcement, nanocomposites, packaging, aerogels, biomedical, cosmetics, etc. However, their production usually requires intensive and energy consuming multi-step processes.

Objectives — The aim of this study is to produce L-MNFC (lignin-containing MNFC) from Eucalyptus globulus bark by a combinative process including SteamEx as a pre-treatment and to examine the impact of the explosive decompression on their morphology and chemical composition.

Approaches —
Eucalyptus globulus bark was first pre-treated in alkali conditions by steam explosion (200°C, 8 min) or by conventional cooking (170°C, 60 min) for comparison, refined and then grinded until the formation of gels. The chemical composition (Ionic chromatography, FTIR-ATR) of the pulps and morphology of the products (Morfi Neo, Optical and Atomic Force Microscopies (AFM), turbidity). Nanopapers and wood panels were produced from (or including) lignocellulosic microfibrils to investigate the mechanical properties.

Key results — (presented as separated bullet points)

- The L-MNFC produced exhibited web like morphology with fibrils width of 5-100 nm. AFM images showed that L-MNFCs also contain lignin nanoparticles expelled during the explosive decompression.
- SE fibers were more damaged due to the explosive defibration step
- Nanopapers were produced from lignin-containing microfibrils to investigate the mechanical properties.
- the addition 1% of L-MNFC to a UF adhesive significantly improved the properties of the adhesive formulation. The measurement of internal bonding strength, moduli of elasticity and rupture, and thickness swelling of the particleboards produced confirmed this positive effect.

Main conclusions including key points of discussion —
This study showed that steam explosion of wood coproducts can constitute an easy and cheap way to produce cellulose nanofibers for further industrial applications.). This approach could constitute a less energy intensive alternative than conventional processes for the production of nanocellulose fibers.

Perspectives —
The use of these L-NMFC for innovative applications. Utilization of other feedstocks.

Valorization —

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- A low-cost environmentally friendly approach to isolate lignin containing micro and nanofibrillated cellulose from Eucalyptus globulus bark by steam explosion, Saad NADER, Nicolas BROSSE, Malek KHADRAOUI, Cecilia FUENTEALBA, Isabelle ZIEGLER-DEVIN, Fabienne QUILÈS, Sofiane EL KIRAT CHATEL, Evelyne MAURET, Cellulose, 2022, in review
- Nader, S., Khadraoui, M., Segovia, C., Fuentealba, C., Ziegler-Devin, I., Chrisciel, L., Mauret, E., Brosse, N.. NanoSteamEx: production of microfibrillated cellulose by steam explosion. EPNOE Junior Meeting 4th edition organized online on 3-4 February 2021.
- Nader, S., Segovia, C., Fuentealba, C., Ziegler-Devin, I., Quilès, F., El Kirat Chatel, S., Mauret, E., Brosse, N. SteamEx: a novel approach for MNFCs and L-MNFCs. EPNOE 7th International Polysaccharide Conference organized in Nantes on 10-15 October 2021.
- Saad NADER, Production of microfibrillated cellulose by steam explosion process, PhD thesis defended on 15 December 2021 in Grenoble
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Leveraging effect of the project—
This project has enabled the establishment of an international collaboration involving LERMAB, TEC 21- LGP2 in Grenoble and un centre de transfert chilien (UDT à Cocepcion).