Study of the effectiveness of sulfonation in the production of microfibrillated cellulose containing lignin (LCMF) by ultrafine wet grinding

1. <u>Context:</u>

Currently, research is oriented toward the use of microfibrillated cellulose (MFC) as a replacement for fossil-fuel based materials, e.g., in composites, coatings and packaging materials.

The typical raw material is a chemically delignified, bleached cellulose pulp, although more and more research is oriented towards the study of the potential use of unbleached pulp. Indeed, several efforts have been made to find cost-effective methods and raw materials to produce MFC in a more environmentally friendly way.

Actually, the extraction of cellulose nanofibrils containing lignin (LCMF) makes possible the use of a cheaper raw material while eliminating the bleaching stage. In fact, the effect of the presence of lignin is still debated in the scientific literature. This production method allows reducing the energy consumed and subsequently produces a low-cost and promising material for use on an industrial scale (Osong, Norgren, and Engstrand 2013). The literature has also shown that lignin can have two contradictory effects on fibrillation. This effect varies according to the type of pulp used as a raw material. On the one hand, it has been shown for mechanical pulp that the presence of lignin can limit fibrillation by "locking" the individual microfibrils together (Lahtinen et al. 2014). On the other hand, residual lignin can lead to lower energy consumption for fibrillation in the case of chemical pulps (Spence et al. 2011).

A possible explanation is that the hydrophobicity of lignin may play an important role in preventing fibre swelling and fibrillation. In this context, Ämmälä et al. (2019) reported that sulfonation softens the lignin in the cell wall and increases its hydrophilicity and swelling capacity. This study showed that lignin sulfonation is both energetically advantageous in the separation of nano-sized fibrils by Masuko grinding and that the binding capacity of the nano-lignocellulosic fibres LMFC was improved. Subsequently, the resulting sulfonated LCMF with good binding capacity can be excellent candidates for use as reinforcing agents in paper and board products.

2. <u>Objectives:</u>

In this context, *Posidonia oceanica*, a marine biomass, containing around 30% of lignin, is used as a raw material for LCMF production by the combination of twin screw extrusion and ultrafine Masuko grinding.

In order to select the appropriate lignin sulfonation conditions, several sodium sulfite (Na_2SO_3)concentrations, temperatures and reaction times will be tested.

The figure 1 presents the suggested way to produce sulfonated LCMF:

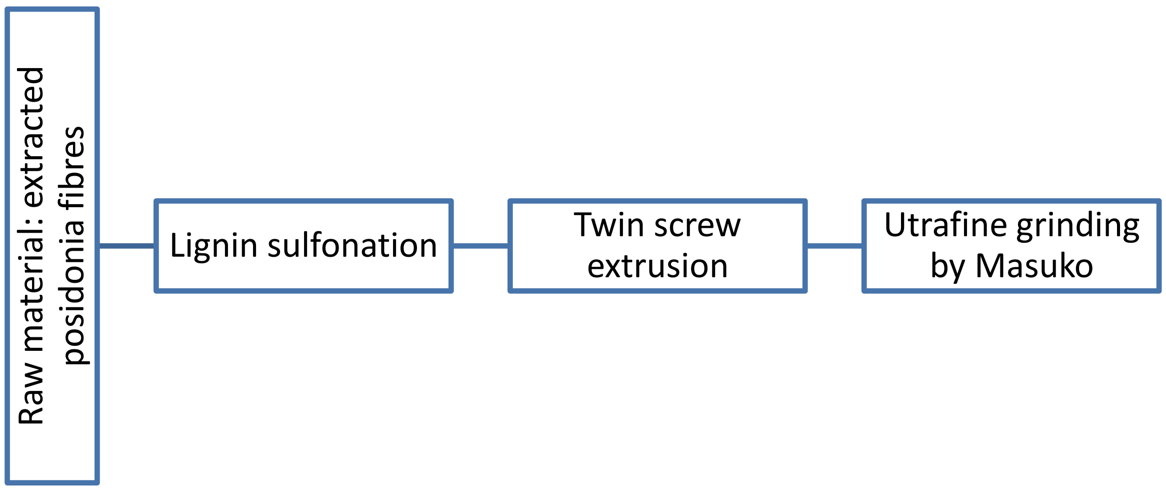

Figure 1: Global way of LCMF production

This work will be divided into several tasks:

- Sulfonation of posidonia fibres in different selected conditions.
- Characterisation of the sulfonated fibres: sulfonic group conductometric titration, WRV (water retention value), optical observation, NeoMorFi (morphological properties), SEM observation.
- Characterisation of the extruded sulfonated fibres: optical observation, NeoMorFi, X-ray diffraction (XRD), mechanical properties of paper.
- Production of the sulfonated LCMF using the ultrafine grinder Masuko from the pretreated fibres.
- Characterisation of the sulfonated LCMF:
    - LCMF suspension: TEM observation, turbidity, nanosized fraction, viscosity.

- LCMF nanopapers: X-ray diffraction (XRD), mechanical properties.
- Energy consumption during the fibrillation process.

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 analyze 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)

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

Bibliographie

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