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Eucalyptus nanofibers as a source of cellulose nanocrystals

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Abstract

The aim of this work was to verify the possibility of directly preparing cellulose nanocrystals from eucalyptus nanofibers by means of acid hydrolysis. The produced nanocrystals were characterized by different techniques. The results were very promising, showing that cellulose nanocrystals with typical needle-like morphology and high degrees of crystalinilty can be obtained.

Key words: Nanocellulose, Acid hydrolysis, Cellulose nanocrystal.

Introduction

In recent years, nanocellulose (cellulose nanocrystal and cellulose nanofiber) received great attention in the development of new materials. Polymeric nanocomposites, hydrogels and films based on nanocellulose exhibit improved mechanical, thermal and barrier properties. The high reactivity, hydrophilicity and hydrogen bonding formation between the cellulose chains are due to the abundant content of hydroxyl groups on the surface of nanocellulose. Cellulose nanofibers (CNF) are usually prepared by physical processing of natural fibers using a high-pressure system in the presence of water. CNF present both amorphous and crystalline regions. On the other hand, cellulose nanocrystal (CNC), a high crystalline material, is mainly obtained by sulfuric acid hydrolysis. Nanocellulose is promising as nanoparticles for gel and film preparation. The aim of this work was to prepare cellulose nanocrystals from eucalyptus nanofiber using acid hydrolysis in order to be used in the preparation of gels and films[1].

Results and Discussion

Eucalyptus nanofibers were hydrolyzed in 65 wt% H_2SO_4 at 55 ºC for 35 min under stirring. Cold water was added to interrupt the reaction and the excess acid was removed by repeated centrifugation cycles. CNC suspension was then dialyzed until neutral pH was reached and lyophilized to obtain CNC powder. Image 1(a) shows the FTIR spectra of CNF and CNC. In this image, characteristic peaks at 3340, 2893 cm^{-1}, assigned to C=O and C-H stretching, respectively, and at 1107 and 1160 cm^{-1}, assigned to C-O-C stretching from cellulose, can be seen. Image 1(b) shows CNF and CNC diffraction patterns, in which both samples presented typical 2θ diffraction peaks at 16, 23 and 34°, assigned to Cellulose I. The calculated degrees of crystallinity are: 45% for CNF and 61% for CNC. CNF and CNC morphologies are present in the FESEM micrographs (Image 2). These micrographs show that the hydrolysis conditions were able to efficiently break CNF interfibrillar links, giving rise to CNC characteristic needle-like structures[2].

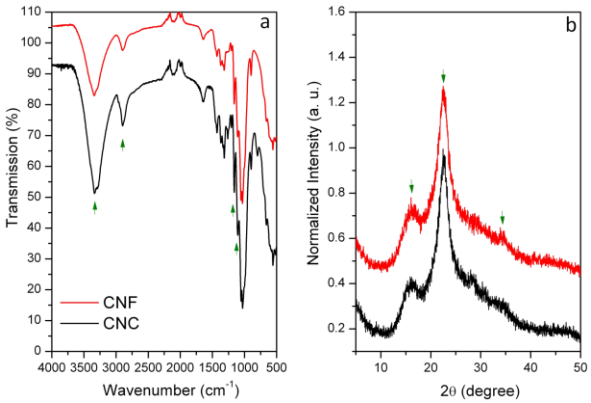

Image 1. (a) CNF and CNC FTIR spectra and (b) the corresponding diffraction patterns.

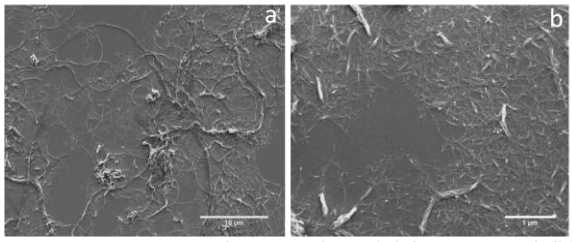

Image 2. FESEM micrographs of (a) CNF and (b) CNC.

Conclusions

The structural and morphological investigation confirmed that with the methodology used in this work it is possible to successfully produce CNC from eucalyptus nanofiber hydrolysis.

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