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Thermal stability of cellulose nanocrystals prepared by succinic anhydride assisted hydrolysis

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Highlights

Cellulose nanocrystals were produced by acid catalyzed hydrolysis.

The thermal stability of CNCs decreased with the increased acid concentration.

New method of mild hydrolysis/esterification by succinic anhydride was presented.

Thermally stable CNC were obtained by simultaneous hydrolysis and esterification.

Abstract

A variety of techniques have been developed recently that enable manufacturing of cellulose nanomaterials with optimal properties for certain applications. Acid catalyzed hydrolysis is currently the most popular method for the synthesis of cellulose nanocrystals (CNCs). However, the type of acids and hydrolysis conditions influence the CNCs thermal stability which is crucial parameter in polymer composite technology. In this work thermally stable CNCs were prepared by two step method – (i) hydrolysis in phosphoric acid solutions to produce fine microcrystalline cellulose (MCC), (ii) followed by modification of MMC with succinic anhydride (SA). The method allowed manufacturing CNC-SA material that showed higher thermal stability than the reference cellulose material (UFC-raw) both in the inert gas and air atmosphere. The kinetic parameters of the thermal degradation process of produced cellulose materials were determined by Friedman and Ozawa-Flynn-Wall model-free methods and compared with CNCs prepared in sulfuric acid. On the basis of changes of apparent activation energy E_a a plausible mechanism of stabilization was discussed. The presented results showed the technological potential of organic acid anhydride application for manufacturing and thermal stabilization of CNCs.

Keywords
Cellulose nanocrystals, whiskers, thermal stability, kinetics of degradation

1. Introduction

Cellulose nanocrystals (CNCs) as a new class of nanomaterials based on renewable resources offer, among other advantages, high modulus and high aspect ratio, low toxicity and abrasion, and wide range of feasible surface functionalization [1-3]. Due to infusible nature of cellulose its nanoparticles are suitable for manufacturing polymeric composites by blending