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Control of the surface properties of cellulose nanocrystals by acylation in water medium

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PURPOSE OF THE ABSTRACT
Cellulose nanocrystals (CNCs) are nanometer-sized rod-like particles, which are increasingly considered as nanoscale building blocks for the elaboration of functional materials with applications in areas as diverse as biotechnology, electronics, optics, energy, packaging or catalysis. The potential benefits of these nanoparticles rely in particular on their high strength, low abrasiveness, high aspect ratio, biocompatibility and inclination for chiral nematic ordering. The application field is a priori vast, but the engineering of innovative functional materials from CNCs requires a fine control of their self-assembling properties and interaction with surrounding materials or in-use environment. This control is generally achieved by chemical functionalization of the CNCs surface, in particular using reactions based on alcohol chemistry.
In this context, we report a sustainable method for the surface tailoring of the CNCs, by transesterification of vinyl esters in water medium. In this work, acetyl functions were easily grafted at the CNCs surface by simply heating under stirring a water dispersion of CNCs in heterogeneous mixture with vinyl acetate, selected as model vinyl ester. The influence of the different reaction parameters (amount of reagent, temperature and reaction time) was investigated by FT-IR and 13C solid-state CP-MAS NMR spectroscopy. The impact of the treatment on the morphology, crystallinity, thermal stability and surface properties of the cellulose nanoparticles was then particularly examined, using techniques such as AFM, TGA, DLS, Turbiscan analysis and contact angle measurements. In optimized conditions, the grafting level could be easily tailored by controlling the reaction time, and up to 90% of the accessible hydroxyl groups at the surface of the CNCs could be esterified.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

cellulose nanocrystals | functionalization in water | acylation | vinyl esters

BIBLIOGRAPHY