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Advanced Bio-Composite Materials Based on Biopolymer Blends and Cellulose Nanocrystals

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Abstract : Recently, more attention has been given to biopolymers with a focus on sustainable development and environmental preservation. Following this tendency, the attempt has been made to replace polymers derived from petroleum with superior biodegradable polymers (biopolymers). In this context, biopolymers are considered potential replacements for conventional plastic materials. However, some of their properties must be improved for better competitiveness, especially regarding their mechanical, thermal and barrier properties. Bio-nanocomposite technology using nanofillers has already been proven as an effective way to produce new materials with specific properties and high performances. With the emergence of nanostructured bio-composite materials, incorporating elongated rod-like cellulose nanocrystals (CNC) has attracted more and more attention in the field of nanotechnology. This study is aimed to develop bio-composite films of biopolymer matrices [Carboxymethyle cellulose (CMC), Starch (ST), Chitosan (CS) and Polyvinyl alcohol (PVA)] reinforced with cellulose nanocrystals (CNC) using the solution casting method. The CNC were extracted at a nanometric scale from lignocellulosic fibers via sulfuric acid hydrolysis and then characterized using X-ray diffraction (XRD), thermogravimetric analysis (TGA), confocal microscopy, infrared spectroscopy (IR), atomic force and transmission electron microscopies (AFM and TEM) techniques. The as extracted CNC were used as a reinforcing phase to produce a variety of bio-composite films at different CNC loading (0.5-10 wt %) with specific properties. The rheological properties of film-forming solutions (FFS) of bio-composites were studied, and their relation to the casting process was evaluated. Then, the structural, optical transparency, water vapor permeability, thermal stability and mechanical properties of all prepared bio-composite films were evaluated and studied in this report. The high performances of these bio-composite films are expected to have potential in biomaterials or packaging applications.

Keywords : biopolymer composites, cellulose nanocrystals, food packaging, lignocellulosic fibers
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