

Toughening mechanism of thermoplastic starch nano-biocomposite with the hybrid of nanocellulose/nanobentonite

Abstract

High flexibility and toughness are key criteria for an effective bioplastic packaging film. However, in most studies, the flexibility of thermoplastic starch (TPS) films is always neglected when targeting their tensile strength improvement. Low film flexibility has limited the development of TPS films in replacing the petrochemical-based plastic packaging films. In this communication, we report a method to produce thermoplastic corn starch (TPCS) films with excellent mechanical strength, high flexibility and high toughness through the hybridization of two natural nanofillers: nanobentonite and nanocellulose. The synergistic effect of the hybrid nanofillers can be observed through the arrangement of alternating nacre structures where the nanobentonite silicate layers are responsible for mechanical strength, while the nanocellulose promotes free volume in the TPCS matrix and triggers high film elongation at break. Structural, morphological, and thermomechanical analysis were conducted, and the detailed strengthening mechanism of the TPCS hybrid nano-biocomposite films was revealed.

Keywords

Nano-biocomposite; Nanocellulose; Nanoclay; Thermoplastic starch; Toughening mechanism