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Mechanical and fracture behaviors of cellulose-based multilayer laminate

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ABSTRACT

Cellulose nanomaterials (CNs) have become attracting recently as a result of renewable and sustainable sources, superior mechanical properties, lightweight and the potential to be produced at industrial size quantities. In this study, two types of CNs, cellulose nanofibrils (CNF) and cellulose nanocrystals (CNCs), were used to fabricate multilayer laminate with various types of polymer, such as poly(vinyl butyral) resin (PVB) and poly(styrene-block-ethylene/butylene-block-styrene) (SEBS). In CNF laminate system, laminate had lower Young's modulus (E) and ultimate tensile strength (s_T) but higher strain of failure (e_f) in comparison with neat CNF film properties, especially using PVB as interlayer. The improvement of e_f of CNF/polymer laminate resulted in more energy was dissipated (work of fracture) during breaking laminate, which was also approved by observing facture surface of laminate where initiating high density of cracks in shear direction as comparison to the smooth fracture section of neat CNF films. In CNC laminate system, most properties (E, s_T, and work of fracture) of the laminate were decreased. However, in CNC/maleated SEBS system, the e_f was increased almost 50% as increasing the volume fraction of polymer. In addition, the stress–strain curves of CNC/maleated SEBS laminate presented multiple breaking steps which represented that cracks propagating through the laminate were delayed by maleated SEBS interlayer polymer.