Ionic Cross-linked Cellulose Nanocrystals Composites of Poly(vinyl acetate)

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Abstract

Understanding the effect on the materials mechanical properties from the perspective of interfacial interaction between the filler and the polymer matrix has become an important criterion in polymer nanocomposites field. Cellulose nanocrystals (CNCs) are renewable materials that can be extracted from natural sources, such as wood, cotton, and tunicates. In addition, CNCs have the characteristics of being rigid rods having high aspect ratio of 10 - 100 with estimated tensile strength (TS) and tensile modulus (E) of ~3 GPa and ~150 GPa, respectively. Due to their prominent mechanical profile and abundance, CNCs have been used with a variety of polymers and studies have shown that the incorporation of CNCs has significant impact on E improvement but less on TS.

This research is designed to investigate the bonding mechanisms at the interphase and the water susceptibility of polymer nanocomposites with the incorporation of carboxylated cellulose nanocrystals (C.CNCs) and C.CNCs modified with multivalent ions (Fe$^{3+}$) in poly(vinyl acetate) (PVAc). Poly (vinyl acetate) (PVAc) is a synthetic polymer commonly used in household glue for wood and paper crafting, was chosen to be the polymer matrix based on its polarity that promotes strong hydrogen bonding between hydroxyl-rich cellulose and the ester group on PVAc backbone. It was found that the incorporation of CNCs improved the mechanical properties (E and TS) in general and the incorporation of iron in general decreased the water susceptibility of the polymer composites; however, CNCs, like most nanoparticles, have the tendency to agglomerate in the polymer matrix. Thus, the quality of CNCs dispersion within the polymer matrix is an important factor on the improvement of mechanical properties.

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