Thermal and Mechanical Behavior of Cellulose Nano-fiber-reinforced Poly(lactic Acid) biocomposites

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Abstract

Over the last decade, there has been considerable interest in the development of biopolymers for replacing petroleum-based synthetic plastics. However, biopolymers developed from renewable resources still need improved performance and lower cost in order to compete with petroleum-based polymers. To address this issue, the use of nano-sized reinforcement has been suggested [1]. Rod-like cellulose nano-fibers (CNs) have attracted considerable attention as reinforcements in composite materials because of their exceptionally high specific strength and modulus, low density, chemical tunability, renewable nature, and relatively low cost [2]. However, the industrial use of CNs is limited because of the difficulty in dispersing them in polymer matrix and their low thermal stability [3]. The large number of hydroxyl groups of cellulose and the nonpolar characteristics of most thermoplastics result in the difficulties in achieving acceptable dispersion levels of nanofiller in the matrix. Moreover, the commonly used methods of preparing CNs from native semicrystalline cellulose lead to the introduction of sulfate groups on the surface of CNWs, which cause a considerable decrease in the degradation temperatures of CNs (Figure 1). In this study, we prepared CNs with high thermal stability using a simple ultra-sound treatment. The nano-fibers were incorporated in the poly(lactic Acid) (PLA) via a melt blending method. The thermal and tensile properties of the CN/PLA biocomposites were tested and compared with those of the unreinforced PLA. The results showed that the presence of CNs improved the thermal and tensile properties of the CN/PLA biocomposites.

References

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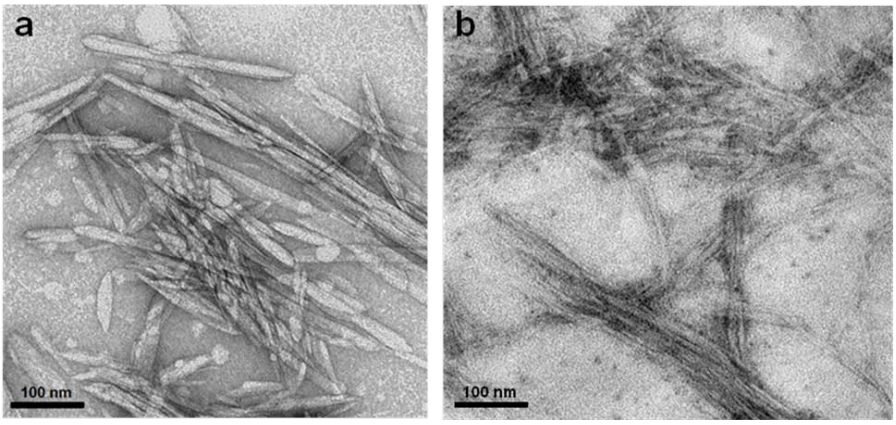

Figure 1. TEM images of the CNWs prepared by (a) sulfuric acid and (b) ultra-sound treatment.