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Poly(vinyl alcohol)-α-chitin composites reinforced by oil palm empty fruit bunch fiber-derived nanocellulose

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ABSTRACT

Poly(vinyl alcohol)-α-chitin composite films reinforced by oil palm empty fruit bunch fiber-derived nanocellulose were prepared by casting technique. Fourier transform infrared spectroscopy analysis revealed partial miscibility between chitin and poly(vinyl alcohol) through hydrogen bonding, as supported by differential scanning calorimetry and field emission scanning electron microscopy. Tensile strength of the poly(vinyl alcohol)/chitin films increased with α-chitin content varied from 10 to 30 wt%, which was from 29.06 to 39.27 MPa. With the addition of 1 wt% nanocellulose, a maximum improvement of 57.64 and 50.66% in terms of tensile strength and Young's modulus was achieved, respectively.

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Cellulose; chitin; composites; mechanical properties; physicochemical properties; poly(vinyl alcohol)

Introduction

There is a trend toward searching for biocompatible and biodegradable formulations with remarkable advantages of sustainability. Poly(vinyl alcohol) (PVA) has attracted significant interest due to its versatile applications in biomedical, food packaging, environmental, and various chemical industries.[1] However, application of PVA is limited by its great affinity to water and lack of biological properties.[2,3] Chitin or poly(*N*-acetyl-D-glucosamine) has proven records of boosting some biological activities such as antibacterial and antioxidant but lacks flexibility and melting processability of PVA.[4] Both PVA and chitin are nontoxic, biocompatible, and biodegradable polymers.[2,3] Therefore, blending chitin with PVA serves as a viable solution for obtaining new material that capitalizes selected advantages of both types of polymers.

Yet, there are limited studies of PVA/chitin systems. Most PVA/chitin studies are based on β-chitin in which polymeric chains are arranged in parallel.[5–7] They have highlighted the proof of miscibility between β-chitin/PVA systems because β-chitin has much weaker intermolecular hydrogen bonding than α-chitin which is ascribable to its parallel chain arrangement. As for mechanical properties, the ultimate tensile strength has been recorded to be below 6 MPa regardless of PVA/β-chitin composition, with great reduction of elongation at break, especially when PVA content is below 40 wt%.[5,6]

In contrast, α-chitin with main chains arranged in antiparallel order has not been extensively studied. α-chitin is characterized by low solubility and reactivity and its physical properties being very rigid and brittle. α-chitin has only been incorporated as reinforcing fillers in the form of insoluble nanofibers or nanowhiskers when blended with PVA.[8,9] With the incorporation of α-chitin into PVA matrix, tensile strength and Young's modulus have been improved while retaining its transparency. To the best of our knowledge, there is no previous report regarding the preparation of

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