Influence of the Molecular Weight of Chitosan on the Spinnability of Chitosan/Poly(vinyl alcohol) Blend Nanofibers

Homa Homayoni,[1] Seyed Abdolkarim Hosseini Ravandi,[1] Masoumeh Valizadeh[2]

[1]*Research Center of Fiber Science and Technology, Textile Department, Isfahan University of Technology, Isfahan, Iran 84156/83111*
[2]*Faculty of Engineering, University of Guilan, Rasht, Iran 3756*

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ABSTRACT: The electrospinning of the biopolymer chitosan (CS) and poly(vinyl alcohol) (PVA) was investigated with 90% acetic acid as the solvent and with different CS/PVA ratios. The long chains of high-molecular-weight CS prevented it from forming nanofibers in a high-voltage field. The treatment of CS under high-temperature alkali conditions reduced its molecular weight exponentially with the treatment time and caused a reduction of the viscosity consequently. PVA, acting as a plasticizer and accompanied by the alkali-treated CS of lower viscosity, made the electrospinning of CS/PVA blends possible. The effects of the duration of the alkali treatment on the molecular weight of CS and its viscosity were investigated and optimized. The diameter of the bicomponent nanofiber decreased proportionally with the increase in the CS portion, whereas the surface porosity increased inversely. Fourier transform infrared studies illustrated that the alkali treatment or blending of CS with PVA had no effect on its chemical nature. © 2009 Wiley Periodicals, Inc. J Appl Polym Sci 113: 2507–2513, 2009

Key words: blends; fibers; polysaccharides; viscosity

INTRODUCTION

Biopolymers as natural-based polymers are of great interest in different fields of science. These materials are progressively used for various applications because of several advantages, such as their nontoxicity and availability, the plenitude of their agricultural or marine sources, their biocompatibility and biodegradability (which lead to ecological safety), and the possibility of producing a variety of chemically or enzymatically modified derivatives for specific uses.[1,2]

Polysaccharides are the major members of the biopolymer family. Cellulose, as the most widely known polysaccharide, is used in textile and paper industries, and chitin and its derivatives, as the next most important members, are used in food, pulp and paper industries, biotechnology, agriculture, cosmetics, wastewater treatment, and medicine.

Chitin is α-(1→4)-linked 2-acetamido-2-deoxy-β-D-glucose and is derived from crustacean shells, byproducts of lobsters, crabs, and the like. It can be found in other natural sources such as yeasts, fungi, and insects.

Correspondence to: S. A. H. Ravandi (hoseinir@cc.iut.ac.ir).

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Chitosan (CS), the partially deacetylated and most operational derivative of chitin, is insoluble in water, alkali, and most mineral acidic systems. Its solubility in inorganic acids is quite limited, but it is soluble in organic acids such as dilute aqueous acetic, formic, and lactic acids. In the presence of a limited amount of acid, it is soluble in water–methanol, water–ethanol, and water–acetone mixtures. CS has incomparable specifications that enrich it with excessive physicochemical properties such as swelling, hydrogelation, wound healing, antibacterial attributes, and particular chemical and physical absorption properties; this makes it convenient for specific applications.[3–6]

Combining these properties with a nanoscale structure and preparing it in the form of nanofibers and nanowebs, which are actually random assemblies of nanofibers (similar to the structure of felt), optimize its other physical properties. In recent years, researchers have made attempts to produce it in the form of nanofibers, the finest morphology accessible by fibers, revealing a high porosity, a high aspect ratio, and structural compatibility with vital cells.[7,8]

However, CS is a polycationic polymer, and the fabrication of CS nanofibers through electrospinning, which is recognized as the most efficient method for producing ultrafine fibers with nanometric diameters, has attendant difficulties because of the high molecular weight, helical structure, and high