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Structures and Properties of Chitosan Based Porous Membranes ⋆

Yeping Xiang [a], Mo Yang [b], Liyun Xu [a], Ruiyun Zhang [a,*]

[a] *Key Laboratory of Textile Science & Technology, Ministry of Education, College of Textiles Donghua University, Shanghai 201620, China*

[b] *School of Economics and Management, Hebei University of Engineering, Hebei 056038, China*

Abstract

In order to improve some defects of pure chitosan membrane, such as the high brittleness and poor flexibility *etc.*. This paper adopted a simple and effective method to realize the performance optimization by blending with Poly Lactic Acid (PLA) and Poly (Vinyl Alcohol) (PVA). The result indicated that compared with pure CS membrane, moisture absorption rate and Water Vapor Transmission Rate (WVTR) of CS/PLAand CS/PVAblend membranes have been greatly improved. With a certain amount of the PLA or PVA, the breaking elongation of the blend membrane rise steadily. The physical properties of CS/PLA blend membrane are better than the CS/PVA's, so the research for CS/PLA blend membrane is expanded. With the Scanning Electron Microscopy (SEM) images, it observed that the CS/PLA blend membrane's porosity is improved after freeze-drying, and have better porous structure, the pore size and morphology with different blending ratios changed significantly. Besidethe SEM images, CS/PLA blend membranes' Fourier transform infrared spectroscopy (FTIR) reveal that the strong hydrogen bonds formed between CS and PLA, which is consistent with the conclusions of the Differential Scanning Calorimetry (DSC). The DSC curve analysis shows that the decomposition temperatures of the blend membrane decrease firstly and then increase with the decrease of CS content. The comprehensive property of the porous membranes is optimal point where the CS content is 60%. The good properties, such as moisture regain, porosity, and water vapor transmission rate, of the kind of CS/PLA or CS/PVA blend membranes suggested a potential application in wound dressing.

Keywords: Chitosan (CS); Poly Lactic Acid (PLA); Poly (Vinyl Alcohol) (PVA); Lyophilization; PorousMembrane; Biodegradation

1 Introduction

Biopolymer material contributed to the medical application is one of the widest application, the fastest development, and thehottest research materials [1]. Nowadays, biopolymer blending mod-

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*Corresponding author.
Email address: ryzhang@dhu.edu.cn (Ruiyun Zhang).

ification has been increasingly investigated. The technology of blending preparation can choose the appropriate blending materials and the proportion of composition to improve the material defects, obtain good mechanical properties, the morphology, the permeability, degradation and so on. Polymer blended are physical mixtures of structurally different polymers or copolymers that interact with secondary forces without covalent bonding, such as hydrogen bonding, dipole-dipole forces, and charge transfer complexes for homopolymer mixtures [2]. In short, the characteristics of optimal combination of different polymers in one, a new performance the material does not have, not only simple and effective, but also considerable economic, open up a broad path for the research and development of polymer materials. The preparation of porous materials by freeze dryingcarried out cast and lyophilize technologyat the same time can maximize the biological and chemical structure of the products and the integrity of the biological activities.

Chitosan is soluble in acid or dilute acid solution, and has some excellent performances like adsorption, integration, and moisturizing membrane, non-toxic to humans, no immunogenicity and good antibacterial. Furthermore its biological compatibility, biodegradability, low toxicity, no allergic effects give it their natural advantages and has good effects of drugs and medical functions, which makes it occupy a larger market application in biology and medicine. But the chitosan molecule is so rigid that its film curls easily. In the dry weather, shrinkage cracking damaged the membrane structure; in the wet weather, absorbing water vapor decreased the membrane strength and the color yellowed [3]. PLA is composed of dehydrated and condensed lactic acid under the suitable conditions, a kind of completely biodegradable polymer. Under certain circumstance, PLA can be decomposed into carbon dioxide and water. PLA fiber and its fabric waste can be processed. However, the disadvantages of PLA due to its chemical structure, like high crystallinity and low crystallization rate, low strength, poor toughness, low thermal deformation temperature (usually only 60 degrees centigrade), high cost and less species, limit the large-scale application in industry [4, 5]. PVA whose performance depends on the degree of polymerization and alcoholysis, a regular molecular structure with molecular chain flexibility polymer, is non-toxic, harmless, and has chemical stability, no reaction with most organic solvents, andhydrophilic [6].

The experiment adopted good biological activity, degradation and absorption chitosan as matrix, and blended PLA or PVA to prepare the blend membrane. On one hand experiment improved the mechanical properties of CS, on the other hand adjusted the biodegradability and degradation of PLA and PVA. This paper carries on the theoretical analysis of polymer membrane, membrane preparation method, the relationship of the proportion of material and membrane structure to obtain the excellent performance and meet requirements of biomedical porous and degradable material. The purpose to prepare porous membrane in this experiment is to meet the requirements of biomedical porous material for wound dressings.

2 Experiment

2.1 Materials, Reagents and Instruments

Materials and reagents: CS (degree of deacetylation $\geq$90%) was purchased from Jinan Haidebei Marine Bioengineering Co. Ltd (China). Poly lactic acid (PLA): Laboratory synthesis; acetic acid, acetone, chloroform, N, N- methyl amide two, two dimethyl sulfoxide (DMSO), sodium hydroxide: analysis of pure, Boer Shanghai Chemical Reagent Co. ltd.