Advanced Materials Research Vols. 123-125 (2010) pp 979-982
© (2010) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMR.123-125.979

Fabrication of novel wound dressing

Chieh Yu Chao [1,2a], Ching Wen Lou[3b], Hsing Wen Sung[4c], Yueh Sheng Chen[2d] and Jia Horng Lin[1,2e]*

[1]Laboratory of Fiber Application and Manufacturing, Department of fiber and composite material, Feng Chia University, Taichung City 407, Taiwan, R.O.C.
[2]School of chinese medicine, China Medical University, Taichung, Taiwan, R.O.C.
[3]Institute of Biomedical Engineering and Material Science, Central Taiwan University of Science and Technology, Taichung 406, Taiwan, R.O.C.
[4] Department of Chemical Engineering, National Tsing Hua University, Hsinchu, Taiwan, R.O.C.

[a]email: cheyu68@hotmail.com, [b]email: cwlou@ctust.edu.tw, [c]email: hwsung@che.nthu.edu.tw, [d]email: yuehsc@mail.cmu.edu.tw, [e]email: jhlin@fcu.edu.tw*

*Corresponding author email: jhlin@fcu.edu.tw

Keyword: Sodium alginate, dressing nonwoven, Low molecular weight chitosan

Abstract

Sodium alginate (SA) is a polyanionic copolymer consist of mannuronic(M) and guluronic(G) sugar residues, it has been comment used in biomedical applications. In this research, polylactic acid (PLA) and Tencel fiber were fabricated into PLA/Tencel composite nonwoven fabric. Then the gel aqueous Ca-SA was combined with PLA/Tencel composite nonwoven fabric by three-dimensional (3D) coating method to form porosity coating layer. Then LMWCS was sprayed on the whole surface to form antibacterial layer. The physical properties of novel wound dressing were evaluated such as tensile strength, tear strength, water absorption rate, stiffness and SEM. In SEM observation result indicated, the coating layer performs highly porosity structure. Between coating layer and PLA/Tencel composite nonwoven fabric was combined by physical bonding. In this way, PLA/Tencel composite nonwoven fabric can remain some part of air permeability and also enhance the strength of dressing.

Introduction

In the past two decades, textile products were drew more and more attention especially nonwoven fabrics owing to its good air permeability, good mechanical properties, simple processing and low cost. Nonwoven fabrics already applied in clinical application, such as operating coat, wound dressing and mask. However, its disposal is an important environmental concern. Biodegradable poymers have been attracted attention in biomedical application [1]. Tencel is regenerated celluosic fiber, which made from wool pulp[2]. It is a biodegrable fiber and the manualfacturing process is a novel solvent-spinning process designed to minimize environmental impacts [3]. The fibers have a high degree of crystallinity and fibrillar morphology and offer different characteristics comparing to cotton fibers [4, 5]. Polylactide(PLA) is one of the most important biodegradable polymer due to its mechanical property profile, thermoplastic processibility and biological properties, such as biocompatibility and biodegradability [6]. PLA is a versatile material made from corn, sugar beets or wheat, an important material in the medical industry and has been used for over 30 years. Moreover, PLA has various mechanical properties in comparison with standard polymers [7]. It can be easy to reprocess depend on its application such as chips, films, fibers and ability to be dissolved in common solvents for processing. However, few

studies have reported on dressing fabric physical properties. In this study, the PLA and Tencel fiber were employed to fabricate PLA composite nonwoven fabric and calcium alginate/ Bletilla striata was used to be the swelling layer. Nonwoven fabric is featured with porosity, larger surface area. PLA fiber can offer good mechanical performance and Tencel mainly enhance the water absorption ability. It can readily be conditioned to serve as an excellent dressing material.

Materials and Methods

Preparation of composite dressing

Alginate (First Chemical Co., Ltd., Taiwan) was dissolved in distilled water to obtain 2 % alginate solution. Bletilla striata (Yi Xing Co., Ltd., Taiwan) solution (10%) was preparation by water extraction. And the nonwoven fabric was made from PLA and Tencel fiber (Far Eastern Textile Ltd., Taiwan).

Well-stirred alginate and bletilla striata solution was blended in different volume ratios (100/0, 80/20, 60/40, 50/50 (v/v)) then stirred for 1hr at room temperature. Afterward, alginate/ bletilla striata solution was crosslinking with $CaCl_2$ solution (0.25 wt %) to form a semi-interpenetrating polymeric network (semi-IPN) within the developed hydrogel system. The Ca- alginate/ bletilla striata solution was poured onto a 3D coating mold and uniform distribution after freeze dryer the composite dressing was obtained.

Scanning electron microscopy (SEM)

The morphology of compound dressing were observed by SEM (HITACHI S-3000N)

Mechanical properties

The blended fibers were opened, blended and formed into fiber webs. Then PLA/Tencel composite nonwoven fabrics were manufactured by needle punching. Subsequently, the tensile strength (According to ASTM D5053 standard), tear strength (According to ASTM D5733 standard) and air permeability (According to ASTM D737 standard) of PLA/Tencel composite nonwoven fabrics were measured in cross machine direction (CD) and machine direction (MD), respectively (shown in figure 1). And the water absorptivity measurment was according to CNS 13905.

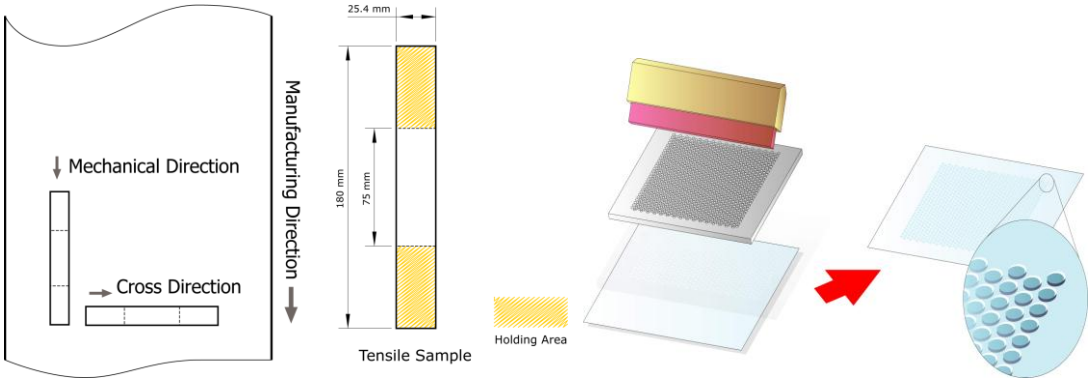


Figure 1. Diagram of mechanical properties measurement specimen and the structure of compound dressing

Results and Discussion

Scanning electron microscopy (SEM)

Figure 2 shown the morphology of compound dressing and we can obviously observed the coating layer had highly porosity structure. Between coating layer and PLA/Tencel composite nonwoven fabric was combined by physical bonding. In this way, PLA/Tencel composite nonwoven fabric can remain some part of air permeability and also enhance the strength of dressing. On one hand some coating layer would permeate into the surface of PLA/Tencel composite nonwoven fabric, and on the other the coating layer could combine with fibers to reinforced composite nonwoven fabric.

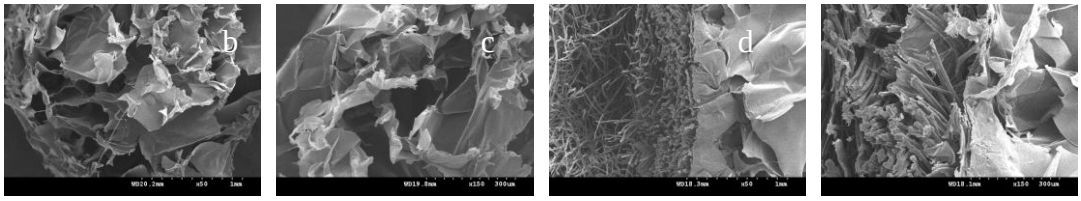
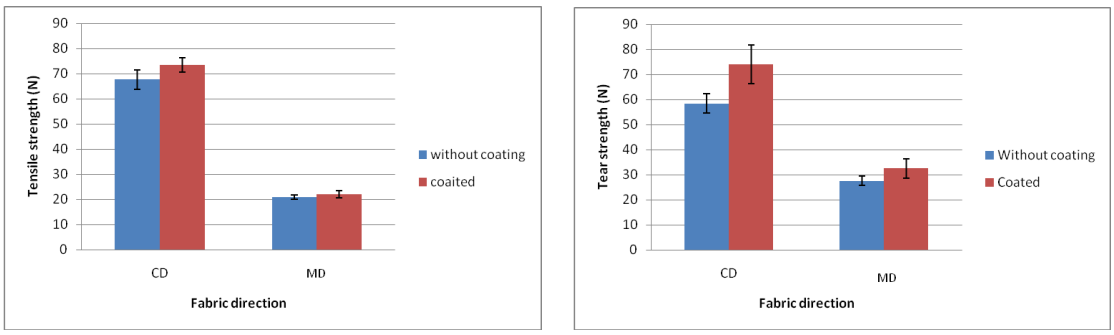


Figure 2. SEM photographs of compound dressing (a) surface 50x, (b) surface 150x, (c) cross-section 50x, (d) cross-section 150x.

Mechanical properties of PLA/ Tencel composite nonwoven fabric

Figure 3 was the tear strength and tensile strength of PLA/ Tencel composites nonwoven fabric (60:40 weight ratios) without coating and after coated. In the tear strength measurement process, among fibers would slide gradually and form a triangle area. When the fibers start sliding, the tension of single fiber would increase rapidly, and the deformation and elongation also rose. If the single fiber were attained a maximum load, the single fiber would break. After coating the coating layer and fiber would combine together so that the mechanical properties of PLA/ Tencel composites nonwoven fabric relatively increased. The results indicated that when PLA/ Tencel composites nonwoven fabric coated with Ca- alginate/ bletilla striata layer the tensile strength was increased 8.5% (cross machine direction (CD)), 5.8% (machine direction (MD)) and in tear strength was increased 26.6% (CD), 17.7% (MD), respectively. Hence, when PLA/ Tencel composites nonwoven fabric coated with Ca- alginate/ bletilla striata layer not only can promote functionality but can enhance mechanical properties.

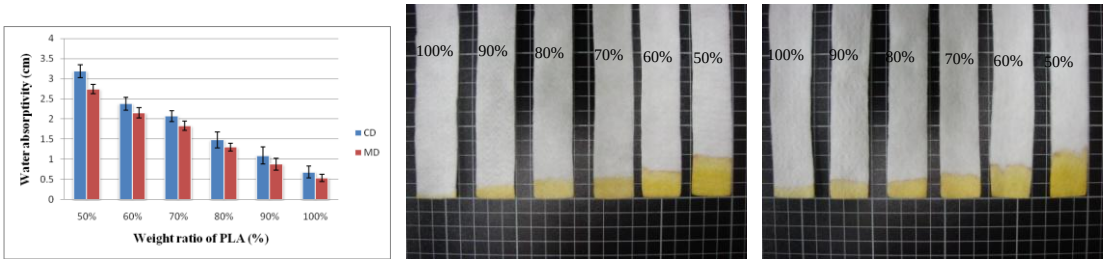


(A) (B)

Figure 3. Mechanical properties of PLA/Tencel composite nonwoven fabric and compound dressing (A) Tensile strength measurement, (B) Tear strength measurement.

Water absorptivity

PLA fiber has good mechanical properties in comparison with standard polymers, but it's surface was barren of hydrophilic functional group such as amino and hydroxyl group. Hence, in this study we used Tencel fiber to improve the water absorptivity of composite nonwoven fabric. In figure 4 indicated that Tencel fiber can obviously increase the water absorptivity of composite nonwoven fabric with the hydroxyl group on Tencel fiber.



(A) (B) (C)

Figure 4. Water absorptivity of PLA/ Tencel composite nonwoven fabric (A) water absorptivity of PLA/ Tencel composite nonwoven fabric in various weight ratio, (B) MD, (C) CD.

Summary

The results indicated that when PLA/ Tencel composites nonwoven fabric coated with Ca-alginate/ bletilla striata layer the tensile strength was increased 8.5% (cross machine direction (CD)), 5.8% (machine direction (MD)) and in tear strength was increased 26.6% (CD), 17.7% (MD), respectively. And in SEM observation result shown the coated layer had highly porosity structure, it may be good at absorb tissue fluid prevent wound from second infection.

Reference

1. Schmack G., Tandler B., Vogel R., Beyreuther R., Jacobsen S., Fritz H. G., J. Appl. Polym. Sci., Vol.73 (1999), p. 2785.
2. Nostro P.L., Corrieri D., Ceccato M., Baglioni P., Journal of Colloid and Interface Science, Vol. 236(2001), p. 70.
3. Shin Y., Son K., YOO D. I., Journal of Applied Polymer Science, Vol.76 (2000), p. 1644.
4. Bartsch P., Kling G., Lenzinger Berichte, Vol.80 (2001), p. 40.
5. Okubayashi S., Griesser U. J., Bechtold T., Carbohydrate Polymers Vol. 58 (2004), p. 293.
6. Gupta B., Revagade N., Hilborn J., Prog. Polym. Sci., Vol. 32 (2007), p. 455.
7. Solarski S., Ferreira M., Devaux E., Polymer Vol. 46 (2005) p. 11187.