

PREPARATION AND CHARACTERIZATION OF ATACTIC POLY(VINYL ALCOHOL)/SILVER COMPOSITE NANOFIBERS

Won Seok Lyoo ¹, Young Jae Lee ¹, Sun Gil Kim ¹, Kyeong Il Oh ¹, Jin Wook Cha ¹, Du Hyun Song ¹, Han Yong Jeon ², and Sung Soo Han ¹

¹ *Division of Advanced Organic Materials, School of Textiles, Yeungnam University, Gyeongsan 712-749, Korea*

² *Division of Nano-systems Engineering, Inha University, Incheon, 402-751, Korea*

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INTRODUCTION

Recently, incorporation of silver nanoparticles into ultrafine fibers has attracted a great deal of attention, because the resulting fibers have very strong antimicrobial activity.¹ Electrospinning is a unique method, which produces polymer fibers with diameter in the range from nano to a few micron using electrically driven jet of polymer solution or melt. When a strong electrostatic force is applied to the capillary containing a polymer solution, it is ejected from the capillary and deposited as a nonwoven fibrous mat on a template serving as the ground for the electric charges.

In this study, the poly(vinyl alcohol) (PVA)/silver composite nanofibers were electrospun from a PVA solution with small amounts of water-based silver colloidal solution. This method does not need any tedious post processing such as the precipitation-redissolution and photoreduction procedures employed by others investigations, or any external reducing agents.

EXPERIMENTAL

Materials

PVA was purchased from DC Chemical Co., Ltd., Seoul, Korea. The number-average degree of polymerization (P_n) and saponification of PVA were 1700 and 99%, respectively. To synthesize high molecular weight (HMW) a-PVA, having a P_n of 4000, Vinyl acetate (VAc) was suspension polymerized in water at 40 °C with 2,2'-azobis(2,4-dimethylvaleronitrile) (ADMVN) as an initiator, followed by subsequent saponification. Water-based silver colloidal solution was supplied from MIJI TECH Co., Ltd., Ansan, Korea. Initial concentration of water-based colloidal silver (AGS-WP001[®]) was 10000 ppm. The diameter of silver nanoparticles in the colloidal solution were at 30 ~ 50 nm.

Electrospinning Set-up

In order to prepare the PVA/silver composite nanofibers, various concentration of a-PVA aqueous solution with small amounts of silver colloidal solution (0.2, 0.5, and 1.0 wt% to amount of PVA) were electrospun. PVA was dissolved in water at 90 °C for 2 h and maintained for 30 min to ensure homogenization. Concentration of PVA aqueous solution was varied from 3 to 9 wt%. To prepare homogeneous polymer solution containing silver nanoparticles, silver colloidal solution at 0.2, 0.5, and 1.0 wt% of PVA was mixed to the PVA solution at 60 °C for 30 min. The electrospinning setup consist of a syringe and needle (ID= 0.95 mm), an aluminum collecting drum, high-voltage supply (Dongyang, Co., Daegu,

Korea). Applied voltage was ranged from 15 to 30 kV. Tip-to-collector distance (TCD) was varied from 7 to 30 cm.

Characterization

The morphologies and compositional of a-PVA nanoweb were analyzed by the field emission scanning electron microscopy (FE-SEM) (Hitachi S-4100, Tokyo, Japan) after gold coating, and energy-dispersive X-ray analyses (EDAX) techniques. The average diameters of the a-PVA nanoweb were determined by analyzing SEM images with a custom code image analysis program. Transmission electron microscopy (TEM) images were obtained with a Philips CM 200 (Eindhoven, Netherlands) using samples deposited on carbon coated copper grids.

RESULTS AND DISSCUSSION

Aaccording to the amount of silver colloidal solution, the PVA/silver spinning solution became more, viscous, which could make more energy needed to overcome surface tension for electrospinning, resulting in more thicker fiber ($430 \sim 680 \pm 50$ nm), as seen in Fig. 1(b), and then the thinner fine fiber without any beads with diameter 400 ± 50 nm and 300 ± 50 nm were obtained, as seen in Fig. 1(c) and (d), respectively.

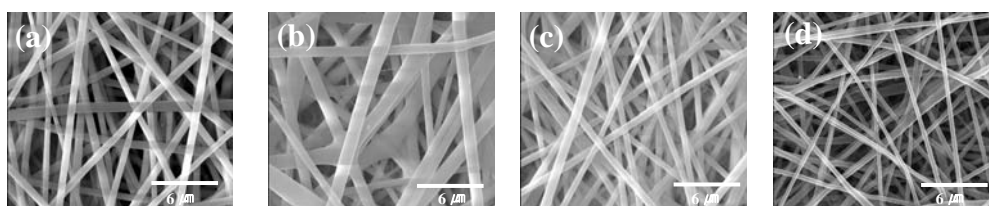


Fig. 1: SEM photographs of PVA/silver composite nanofibers having a P_n of 1,700 electrospun from 9 wt% PVA solution with different amounts of silver colloidal solution: (a) 0 wt%, (b) 0.2 wt%, (c) 0.5 wt%, and (d) 1.0 wt%. The applied voltage, and TCD were 25 kV, and 30 cm, respectively.

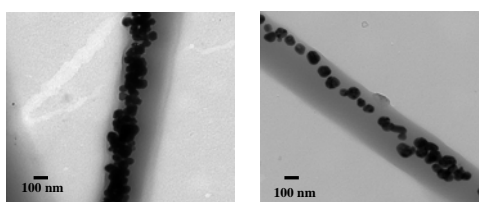


Fig. 2: TEM images of PVA nanofiber electrospun from 9 wt% PVA solution with 1.0 wt% silver colloid solution.

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