나노 사이즈의 은 콜로이드를 이용한 PE/PP 부직포의 항균성에 관한 연구

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A study on antibacterial property of padded PE/PP nonwovens with nano-silver colloidal solution

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1. Introduction

Silver has antibacterial property on bacteria of about 650 kinds and has been well known as non-toxic and non-tolerance in natural state. Recently, silver has been applied disinfection and antibacterial property to everyday life as health foods, filter, and exclusion of pollution. Nano-sized silver particle have very small size (<10nm) and wide surface area per unit volume. PE/PP nonwovens used as back sheet or coverstock of baby diaper, adult diaper, sanitary napkin, and wiper. These were easy to be contaminated by bacterium and caused diseases through moisture and dirt. In this paper, the nonwovens had antibacterial property by finishing nano-silver colloid. We evaluated antibacterial efficacy of three types(water based silver colloid, ethanol based silver colloid and ethanol based silver colloid by compounded with sulfide) and reduction rate of bacteria in proportion to time.

2. Experimetal

Nano colloidal silver (three types colloidal solution) was supplied from NP-Tech co., Ltd., Korea. Initial concentration of water-based colloidal silver (*NSW-5000®*) is 5000ppm. One of ethanol-based nanosilver colloid (*NSE-1000®*) was 1000ppm. The super nano colloidal silver (*SNSE-1000®*) was prepared with compounding sulfide and the dispersion solution was ethanol. The concentration of colloidal silver solutions was varied as 5ppm, 10ppm, and 20ppm by diluting each nano silver colloid solution with distilled water. Fabric samples used for PE/PP spun-bond nonwovens, density is 2.1 mg/cm^2, and thickness is 0.17mm. They were provided from Korea vilene co., Ltd., Korea. The nonwovens were padded with each concentration colloid solutions at the pressure of 3.0 kgf/cm^2, by using auto fade mangle. They were immediately dried at 120℃ for 3 min. In order to study antibacterial properties of fabrics finished with nano-silver colloid, we used AATCC-100 Test Method (antibacterial activity assessment of textile materials). Otherwise, the test bacterium cultivated directly in the nano silver colloid of various concentrations. And then percent reduction of bacteria was observed at the each elapsed time (5, 15, and 30 min). The morphology and size of the particles formed in various solutions were investigated by transmission electron microscope (TEM). We observed dispersion and cohesion of nano-silver particle on fiber by scanning electron microscope (SEM). UV-visible spectra of each silver colloids were taken with a UNICAM 8700 spectrophotometer.

3. Result and Discussion

Mean of Ag particle size in water based colloid is 8.11nm, and ethanol based silver colloid is about 3nm by TEM image. Besides, ethanol based silver colloid was dispersed evenly without aggregation. The antibacterial properties of fabric treated with nano silver colloid are shown in Table 1. Percent reduction of bacteria on fabric by finishing nano-silver colloid was 98.6~99.9% against *S. aureus*. When concentration of ethanol based nano silver is more than 20ppm or nano silver compounded sulfide had good antibacterial property against *K.pneumoniae*. Antibacterial efficacy of Water based nano-silver colloid less than one of ethanol based nano-silver colloid Ethanol has a higher dispersion of silver particles than water, size of nano silver particle in the ethanol base smaller than one in the water base. Thus we obtained bacteria reduction rate of nano-silver colloid(ethanol based with compounding sulfide) in proportion to time. After 5 min, *S. aureus* bacteria decreased from 1.2×10^5 to 3.1×10^2 (1/500) and *E. coli* bacteria were disinfected below 10 in 3ppm nano-silver colloid. After 15min, the *S. aureus* bacteria were disinfected completely below 10. Both *S. aureus* and *E. coli* are decreased below 10 within 5 min in Nano silver colloid of 12ppm. It was revealed that Ag-ion itself had dominant antibacterial efficacy.

4. Conclusion

We used nano-silver colloid and obtained excellent antibacterial property on nonwovens in spite of low concentration. We can expect high performance as these applied to back sheet or coverstock of baby diaper, adult diaper, sanitary napkin, and wiper.

5. Reference

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Table 1. Bacteria Reduction of nonwovens by finished with nano-silver colloid.

Bacteria	*S.aureus*			*K.pneumoniae*		
Start	1.3×10^5	1.3×10^5	1.3×10^5	1.2×10^5	1.2×10^5	1.2×10^5
Samples	untreated	NSW-10[a]	NSW-20[b]	untreated	NSW-10[a]	NSW-20[b]
After 24hr	7.3×10^7	9.9×10^5	<10	6.8×10^7	5.5×10^7	5.4×10^7
% reduction of bacteria	-	98.6	99.9	-	18.5	19.4
Samples	untreated	NSE-10[c]	NSE-20[d]	untreated	NSE-10[c]	NSE-20[d]
After 24hr	7.3×10^7	1.5×10^5	1.5×10^5	6.8×10^7	5.8×10^7	<10
% reduction of bacteria	-	99.8	99.8	-	14.2	99.9
Samples	untreated	SNSE-10[e]	SNSE-20[f]	untreated	SNSE-10[e]	SNSE-20[f]
After 24hr	7.3×10^7	<10	<10	6.8×10^7	<10	<10
% reduction of bacteria	-	99.9	99.9	-	99.9	99.9

[a] padded 10 ppm water based nano-silver colloid on spun-bond nonwovens.
[b] padded 20 ppm water based nano-silver colloid on spun-bond nonwovens.
[c] padded 10 ppm ethanol based nano-silver colloid on spun-bond nonwovens.
[d] padded 20 ppm ethanol based nano-silver colloid on spun-bond nonwovens.
[e] padded 5 ppm ethanol based nano-silver colloid with compounding sulfide on spun-bond nonwovens.
[f] padded 20 ppm ethanol based nano-silver colloid with compounding sulfide on spun-bond nonwovens.