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APPENDICES

Determination of Molecular Weight of Chitosan

Table 1 Running time of solvent and chitosan treated 1st solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	122.97	123.22	123.16	123.1167
0.0250	137.88	137.97	138.00	137.9500
0.0500	172.75	172.22	172.19	172.3867
0.0750	208.28	208.25	208.50	208.3433
0.1000	248.94	249.03	249.91	249.2933

Table 2 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1257	0.1257	10.0524	9.4692
0.0250	1.2613	0.2613	10.4511	9.2850
0.0500	1.5761	0.5761	11.5226	9.0995
0.0750	1.9049	0.9049	12.0651	8.5923
0.1000	2.2793	1.2793	12.7929	8.2386

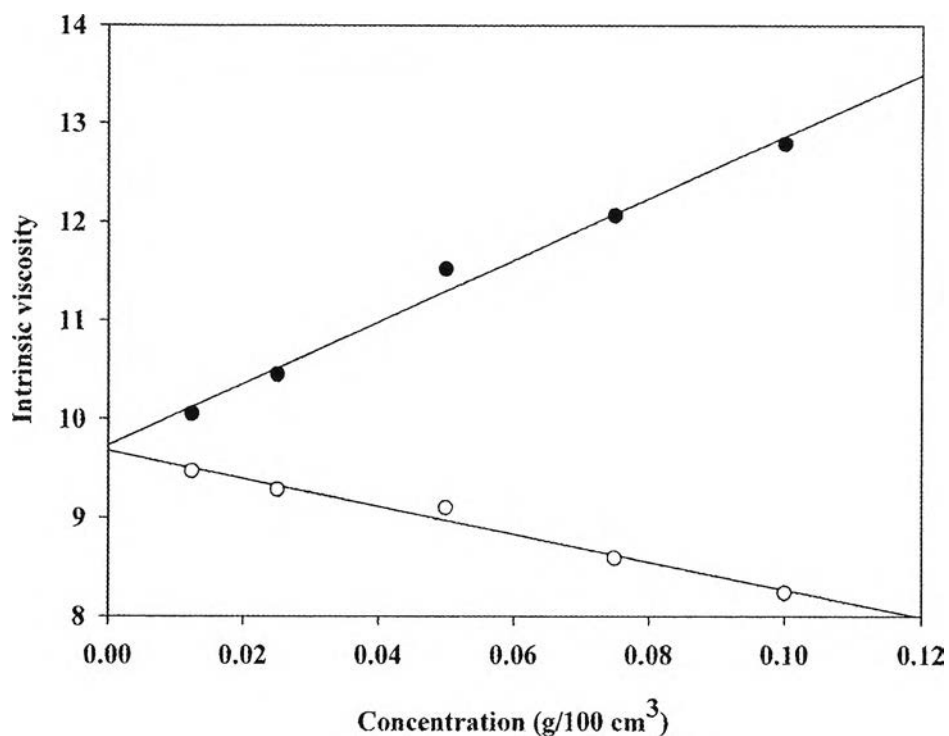


Figure 1 Plot of reduced viscosity (η_{sp}/c) and $\ln((\eta_{rel})/c)$ versus concentration of chitosan solution: ● = (η_{sp}/c) and ○ = $\ln((\eta_{rel})/c)$.

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})M^{0.88}$$

where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 9.703$

From calculation;

$$M^{0.88} = (9.703)/6.59 \times 10^{-5} = 1.47 \times 10^5$$

$$0.88 \log M = \log[1.47 \times 10^5]$$

$$\log M = 5.87$$

$$M = 7.46 \times 10^5$$

The viscosity-average molecular weight of chitosan obtained from calculation was 7.46×10^5 g/mol.

Table 3 Running time of solvent and chitosan treated 2nd solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	123.85	123.56	123.59	123.6667
0.0250	138.25	138.12	138.28	138.2167
0.0500	171.90	171.75	171.84	171.8300
0.0750	206.00	206.22	206.25	206.1567
0.1000	245.78	245.90	245.78	245.8200

Table 4 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1307	0.1307	10.4547	9.8258
0.0250	1.2637	0.2637	10.5486	9.3622
0.0500	1.5710	0.5710	11.4208	9.0348
0.0750	1.8849	0.8849	11.7985	8.4516
0.1000	2.2475	1.2475	12.4753	8.0983

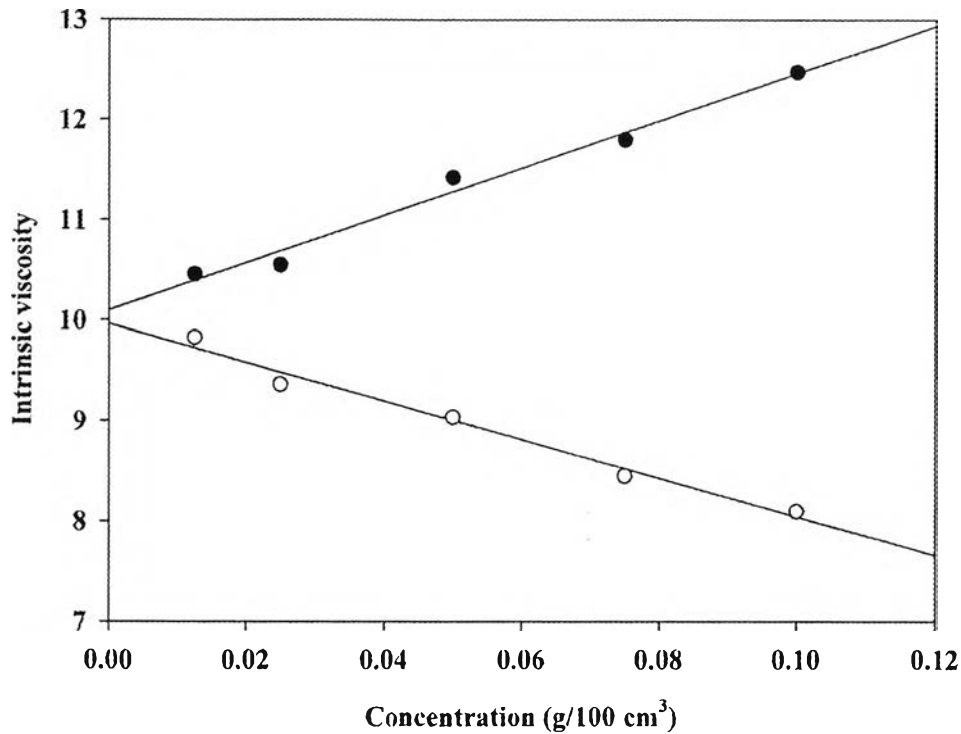


Figure 2 Plot of reduced viscosity (η_{sp}/c) and $\ln((\eta_{rel})/c)$ versus concentration of chitosan solution: ● = (η_{sp}/c) and ○ = $\ln((\eta_{rel})/c)$.

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})M^{0.88}$$

where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 10.030$

From calculation;

$$M^{0.88} = (10.030)/6.59 \times 10^{-5} = 1.52 \times 10^5$$

$$0.88 \log M = \log[1.52 \times 10^5]$$

$$\log M = 5.89$$

$$M = 7.75 \times 10^5$$

The viscosity-average molecular weight of chitosan obtained from calculation was 7.46×10^5 g/mol.

Table 5 Running time of solvent and chitosan treated 3rd solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	121.28	121.16	121.18	121.2067
0.0250	133.66	133.47	133.82	133.6500
0.0500	160.81	161.06	161.19	161.0200
0.0750	191.24	191.15	191.16	191.1833
0.1000	225.25	225.75	225.53	225.5100

Table 6 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1082	0.1082	8.6650	8.2184
0.0250	1.2220	0.2220	8.8785	8.0183
0.0500	1.4722	0.4722	9.4441	7.7352
0.0750	1.7480	0.7480	9.9721	7.4462
0.1000	2.0618	1.0618	10.6184	7.2360

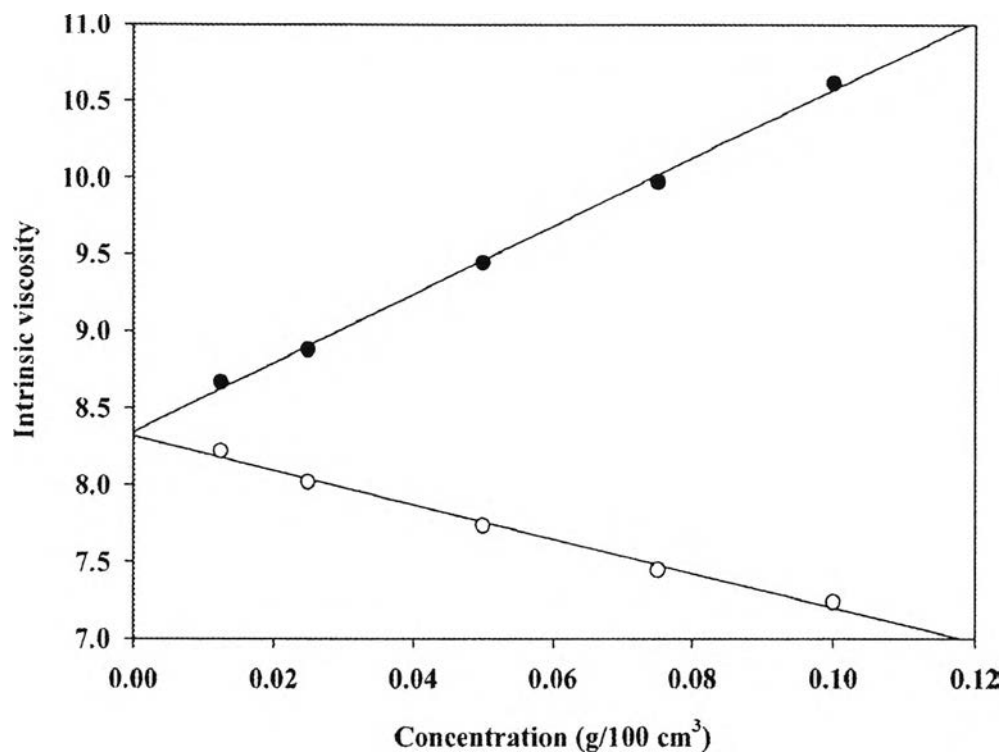


Figure 3 Plot of reduced viscosity (η_{sp}/c) and $\ln((\eta_{rel})/c)$ versus concentration of chitosan solution: ● = (η_{sp}/c) and ○ = $\ln((\eta_{rel})/c)$.

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})M^{0.88}$$

where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 8.331$

From calculation;

$$M^{0.88} = (8.331)/6.59 \times 10^{-5} = 1.26 \times 10^5$$

$$0.88 \log M = \log[1.26 \times 10^5]$$

$$\log M = 5.10$$

$$M = 6.27 \times 10^5$$

The viscosity-average molecular weight of chitosan obtained from calculation was 6.27×10^5 g/mol.

Table 7 Running time of solvent and chitosan treated 4th solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	118.93	118.92	118.98	118.9433
0.0250	129.15	128.84	129.03	129.0067
0.0500	151.47	151.64	151.38	151.4967
0.0750	176.78	176.65	176.85	176.7600
0.1000	204.99	204.89	204.98	204.9533

Table 8 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.0875	0.0875	6.9999	6.7104
0.0250	1.1795	0.1795	7.1803	6.6039
0.0500	1.3851	0.3851	7.7027	6.5159
0.0750	1.6161	0.6161	8.2149	6.4003
0.1000	1.8739	0.8739	8.7389	6.2802

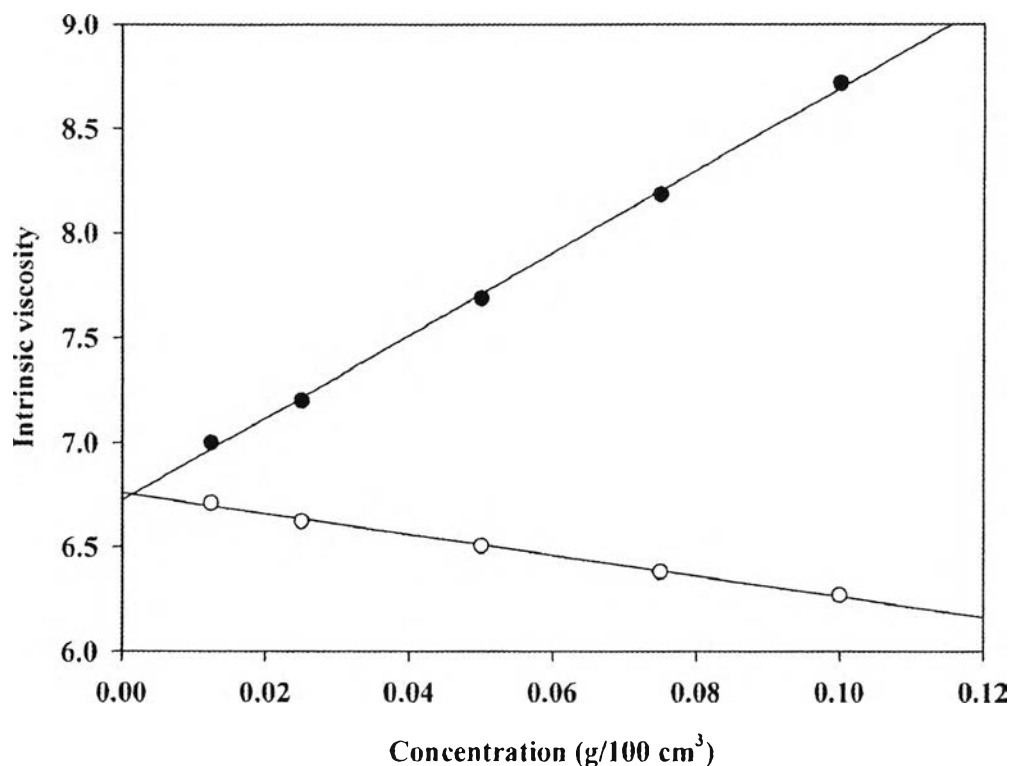


Figure 4 Plot of reduced viscosity (η_{sp}/c) and $\ln((\eta_{rel})/c)$ versus concentration of chitosan solution: ● = (η_{sp}/c) and ○ = $\ln((\eta_{rel})/c)$.

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})M^{0.88}$$

where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 6.741$

From calculation;

$$M^{0.88} = (6.741)/6.59 \times 10^{-5} = 1.02 \times 10^5$$

$$0.88 \log M = \log [1.02 \times 10^5]$$

$$\log M = 5.69$$

$$M = 4.90 \times 10^5$$

The viscosity-average molecular weight of chitosan obtained from calculation was 4.90×10^5 g/mol.

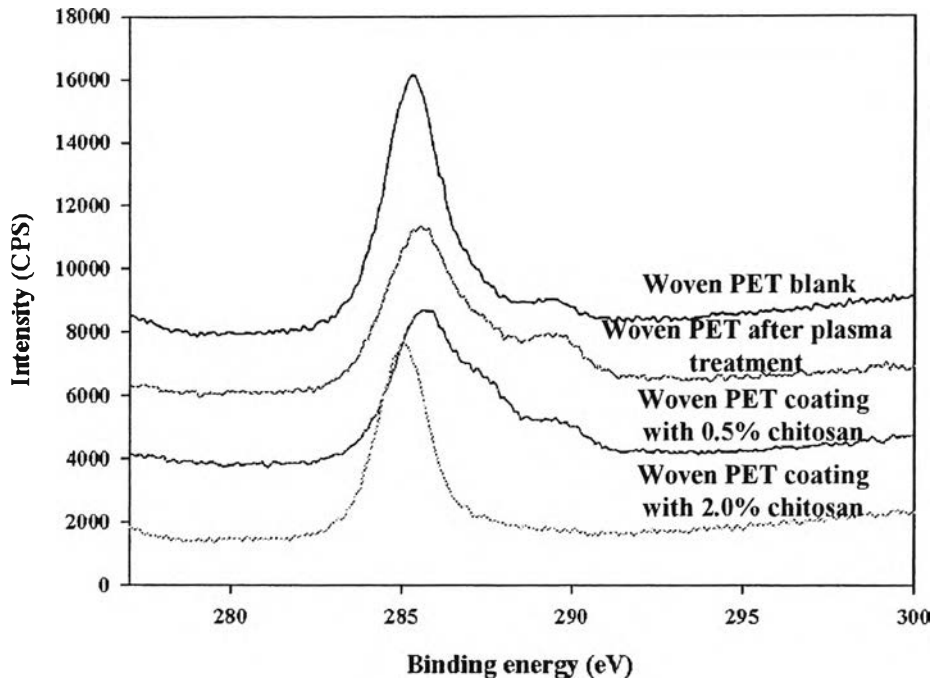


Figure 5 C1s XPS spectra of woven PET.

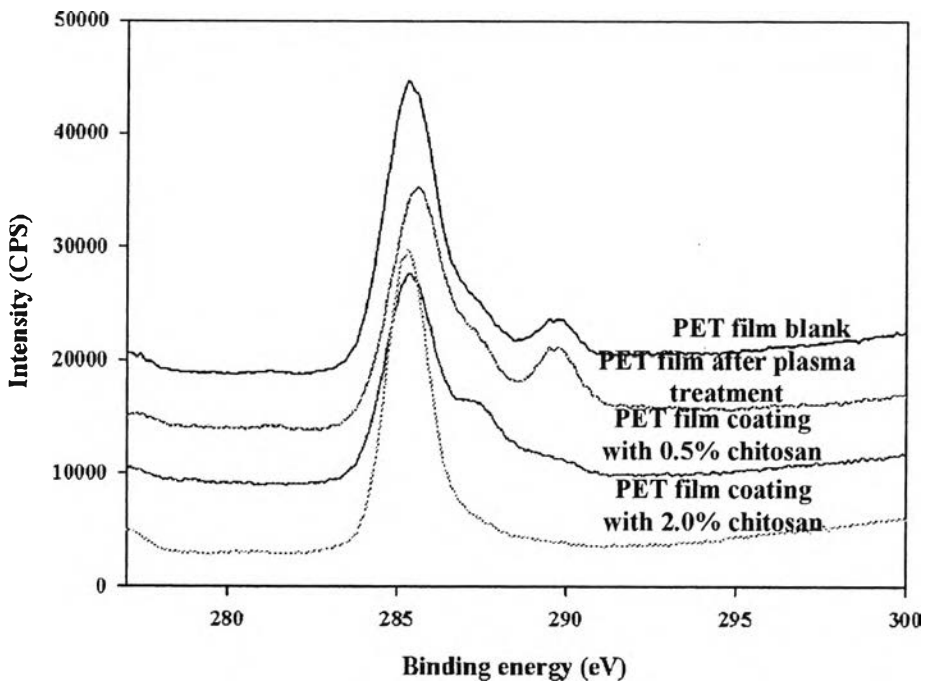


Figure 6 C1s XPS spectra of PET film.

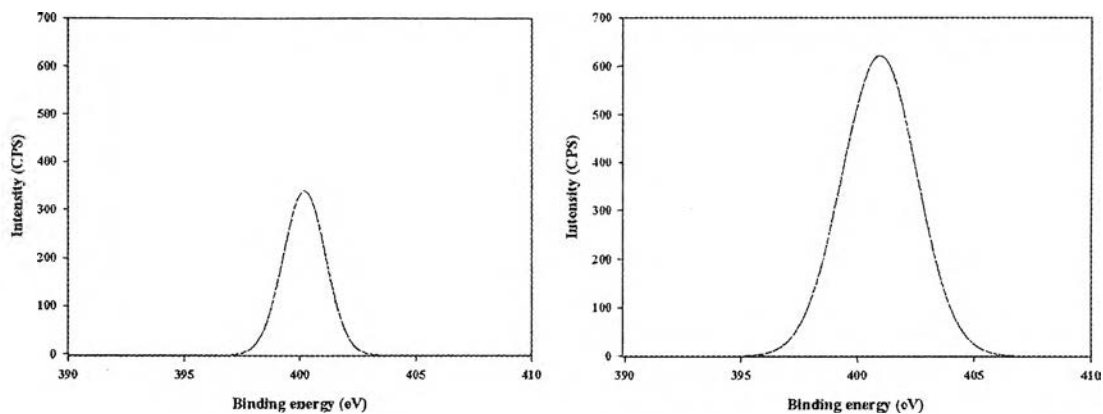


Figure 7 N1s XPS spectra of chitosan-coated PET film (a) PET film coated with 0.5 % chitosan concentration, and (b) PET film coated with 2.0% chitosan concentration.

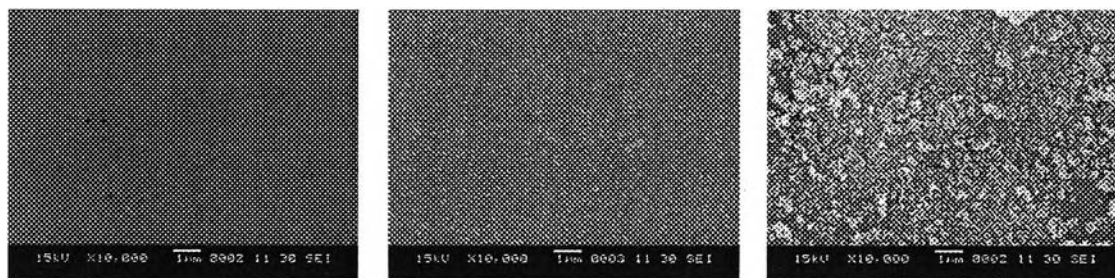
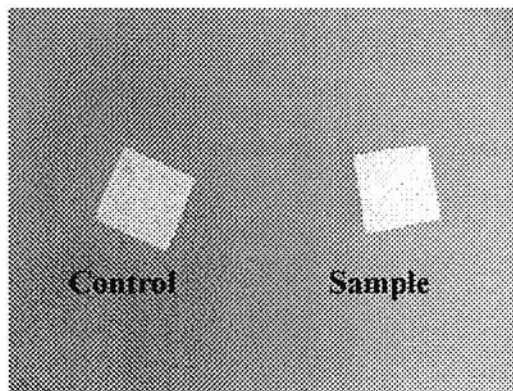
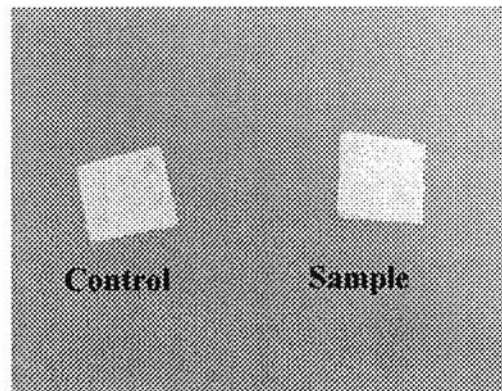


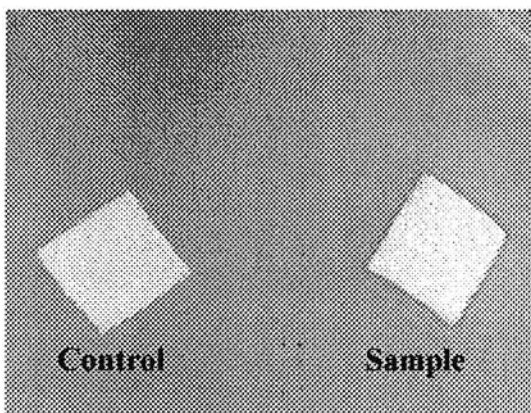
Figure 8 SEM images of PET film (a) without chitosan coating, (b) non-plasma treatment with 1.0% chitosan coating, and (c) plasma treatment with 1.0% chitosan coating.



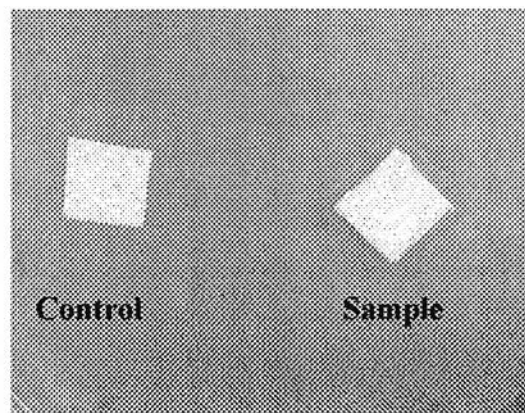
a.) Chitosan 0.5%, with 85% DD



b.) Chitosan 1.0%, with 85% DD

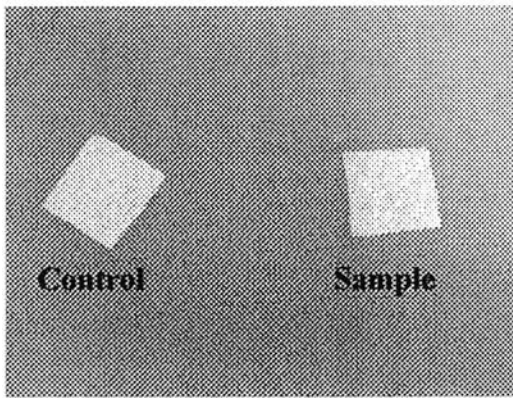


c.) Chitosan 0.5%, with 98% DD

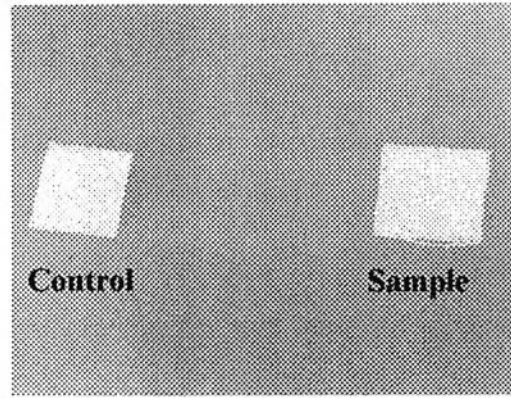


d.) Chitosan 1.0%, with 98% DD

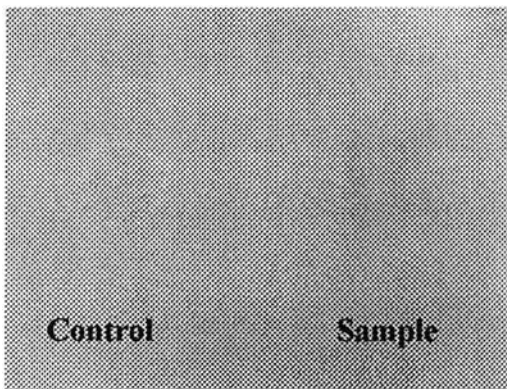
Figure 9 Effects of concentration of chitosan solutions and degree of deacetylation (%DD) on clear zone distance for *S. aureus*. For a. and b., the woven PET is submerged in chitosan solutions with 85% degree of deacetylation and in c. and d. the woven PET is submerged in chitosan solutions with 98% degree of deacetylation.



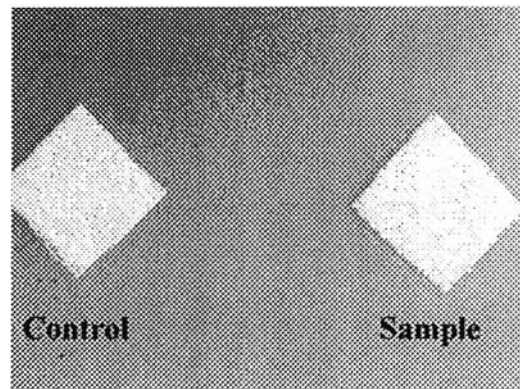
a.) Chitosan 0.5%, with 85% DD



b.) Chitosan 1.0%, with 85% DD



c.) Chitosan 0.5%, with 98% DD



d.) Chitosan 1.0%, with 98% DD

Figure 10 Effects of concentration of chitosan solutions and degree of deacetylation (%DD) on clear zone distance for *E.coli*. For a. and b., the woven PET is submerged in chitosan solutions with 85% degree of deacetylation and in c. and d. the woven PET is submerged in chitosan solutions with 98% degree of deacetylation.

Table 9 Effect of the number of washing cycle on amount of chitosan on woven PET

Chitosan concentration (g/100 ml)	Number of washing cycle (Times)	Amount of chitosan on woven PET (wt. of chitosan (mg/g of sample))
0.5	0	12.104
	1	10.902
	2	9.497
	3	8.131
	4	8.090
	5	8.117
1	0	22.620
	1	20.360
	2	17.641
	3	15.605
	4	15.640
	5	15.617
2	0	27.174
	1	23.749
	2	20.360
	3	18.294
	4	18.357
	5	18.388

Table 10 Amount of chitosan on woven PET at various chitosan concentrations.

Chitosan concentration (g/100 ml)	[Chitosan] after digestion (mg)	[Chitosan] on woven PET (wt. of chitosan (mg/g of sample)
0.1	0.4034	2.025
0.2	1.1301	5.745
0.5	2.423	12.104
0.75	3.392	17.545
1	4.523	22.621
2	5.411	27.302
3	5.572	27.688
4	5.598	27.730

Table 11 Effect of the temperature on coating on amount of chitosan on woven PET

Chitosan concentration (g/100 ml)	Temperature (°C)	Amount of chitosan on woven PET (wt. of chitosan (mg/g of sample)
0.1	Room temp. (25 °C)	2.025
	50	2.018
0.5	Room temp. (25 °C)	12.100
	50	12.190
1.0	Room temp. (25 °C)	23.100
	50	22.620

CURRICULUM VITAE

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Proceedings:

1. Sophonvachiraporn, P., Rujiravanit, R., Chavadej, S., Sreethawong, T., and Tokura, S. (2008, August 19-20) Surface modification of woven PET by dielectric barrier discharge (DBD) plasma technique for antimicrobial property improvement. Proceedings of Thai-Japan Joint Symposium on Advances in Materials Science and Environmental Technology, Bangkok, Thailand.
2. Sophonvachiraporn, P., Rujiravanit, R., Chavadej, S., Sreethawong, T., and Tokura, S. (2009, April 22) Chitosan coating on a woven PET surface modified by DBD plasma technique for antimicrobial property improvement. The 15th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

