REFERENCES

1. วีระศักดิ์ อุดมกิจเดชา. <u>วิทยาศาสตร์เส้นใย (Fiber Science)</u>. กรุงเทพมหานคร :
   จุฬาลงกรณ์มหาวิทยาลัย, 2542.

2. Kroon-Batenburg, L.M.J.; Bouma, B.; and Kroon, J. Stability of Cellulose Structures
   Studied by MD Simulations. Could Mercerized Cellulose II be Parallel?.
   <u>Macromolecules</u> 29 (1996) : 5695-5699.

3. Isogai, A.; Usada, M.; Kato, T.; Uryu, T.; and Atalla, R. Solid-State
   CP / MAS ^{13}C-NMR Study of Cellulose Polymorphs. <u>Macromolecules</u> 22
   (1989) : 3168-3172.

4. Ishikawa, A.; Okano,T.; and Jugiyama, J. Fine Structure and Tensile Properties of
   Ramie Fibers in the Crystalline Form of Cellulose I, II, III, and IV. <u>Polymer</u> 38
   No.2 (1997) : 463-468.

5. Hon, D.N., and Shiraishi, N. <u>Wood and Cellulose Chemistry</u>. New York : Marcel
   Dekker, 1991

6. Wakida, T. et al. Dyeing Properties of Cotton Fibers Treated with Liquid-Ammonia.
   <u>Journal of the Society of Dyers and Colorists</u> 111 (May 1995) : 154 -158.

7. French, A.D. Physical and the Orientical Methods for Determining the
   Supramolecular Structure of Cellulose. <u>Cellulose Chemistry and It's
   Applications</u> (1985) : 99 -104

8. Takahashi, M., and Ookubo, M. CP/MAS ^{13}C-NMR and WAXS Studies on the
   Effects of Starting Cellulose Materials on Transition between Cellulose
   Polymorphs. <u>Kobunshi Ronbunshu</u> 51 (1993) : 107 -113.

9. Vander Hart, D., and Atalla, R. <u>Macromolecules</u> 17 (1984) : 1465.

10. Gnosh, S., and Dilanni, D. Estimating the Degree of Mercerization Using
    Near-Infrared Spectroscopy. <u>Journal of Textile Institute</u> 85, No.3 (1994).

11. Cuculo, J.A. et al. A Study on the Mechanism of Dissolution of the
    Cellulose/ NH_3/ NH_4SCN System II. Journal of Polymer Science. Part A 32
    (1994) : 241-247.

12. Segal, L. Effect of Morphology on Reactivity. Cellulose and Cellulose Derivatives.
    Wiley - Interscience, 1971.

13. Plunguian, M. Cellulose Chemistry. New York : Chemical Publishing. 1943.

14. Sarko, A. Journal of Applied Polymer Science 28 (1976).

15. Kolpak, F., and Blackwell, J. Macromolecules 9 (1976) : 273-278.

16. Jone. J. Polymer Science 42 (1960) : 173-188.

17. Sarko, A., and Muggli, R. Macromolecules 7 (1974) : 486-494.

18. Turbak, A., and Sakthivel, A. Paper based on Ph.D. Thesis of A. Sakathivel done
    at Georgia Institute of Technology, Atlanta, Georgia.

19. Tyrone ,L. V. Textile Processing and Properties. Amsterdam : Elsevier Science
    B.V., 1994.

20. Kirk-othmer . Encyclopedia of Chemical Technology. Third edition. Vol.1,
    Willey - Interscience Publication.

21. Warwicker, J. Cellulose Chemistry and Technology 6 (1972) : 85-97.

22. Warwicker, J., and Wright, A. Journal of Applied Polymer Science 11 (1967) :
    659-671.

23. Karmakar, S.R. Chemical Technology in the Pre -Treatment Process of Textiles.
    Amsterdam : Elsevier Science B.V., 1999.

24. อุษา แสงวัฒนาโรจน์. Mercerization. Textile (July-August 1997) : 48-51.

25. Menachem, L.,and Luise, G. R. The Effect of Liquid Anhydrous Ammonia in the
    Structure and Morphology of Cotton Cellulose. Journal of Polymer Science.
    Part C. No.36 (1971) : 213-229.

26. Ishikawa, A.; Kuga, S.; and Takeshl, O. Determination of Parameters in Mechanical
    Model for Cellulose III Fiber. Polymer 39, No.10 (1998) : 1875-1878.

27. Marrinan, H., and Mann, J. Journal of Polymer Science 21 (1956) : 301.

28. Sarko, A. et al. Macromolecules 9 (1976) : 857-863.

29. British Patent 1084612.1967.

30. British Patent 1136417.1968.

31. Hazard, I.D. Mercerizing with Ammonia. ITB Dying / Printing / Finishing 3 (1994) :
    50-56.

32. Lewin, M. and Roldan, L. Journal of Polymer Science, Part C. No.36
    (1971) : 213-229.

33. Zeronian, S. Cellulose Chemistry and Its Applications. John Wiley and Sons.1985.

34. Saafan, A. Textile Research Journal 54 (1984) : 863-867.

35. Pandey, S., and Nair, P. Textile Research Journal (1975) : 648-653.

36. Legrand. C. Journal of Polymer Science 7 (1951) : 333.

37. Takashi, N.; Kiyofumi ,T.; and Katsushiko, N. Elastic Modulus of the Crystalline
    Region of Cellulose Polymorphs. Journal of Polymer Science. Part B 33 (1995):
    1647-1651.

38. Atalla, R. et al. Journal of Wood Chemistry Technology 4 (1984) : 456.

39. Gardiner, E., and Sarko, A. Journal of Applied Polymer Science. Applied Polymer
    Symposium 37 (1983) : 303

40. Standard Test Method for Intrinsic Viscosity of Cellulose. ASTM D 1795.

41. Breaking load and Elongation of woven fabric. The Standard for Method of Testing
    for Textiles. Vol.9.

42. Diaphragm Bursting Strength and Bursting Distension Tester Method.
    The Standard for Method of Testing for Textiles. Vol.19.

43. Mannan, KM. X-ray Diffraction Study of Jute Fiber Treated with NaOH and Liquid
    Anhydrous Ammonia. Polymer 34 (1993) : 2485-2487.

44. Hilda, Z. J. et al. Liquid Ammonia vs. NaOH Mercerization as pretreatment for the Cotton-Butadienediepoxide Reaction. Spectral and Microscopical Studies. Textile Research Journal (1975) : 681-691.

APPENDIX

Table A1 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I (cotton knitted fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.57	296.23	233.99	198.94	176.00	159.17
2	72.64	295.97	233.26	197.74	175.62	158.75
3	72.61	295.46	232.8	197.31	175.06	158.32
Average flow time	72.61	295.92	233.35	198.00	175.56	158.75
SD	0.0351	0.4371	0.6001	0.8448	0.4729	0.4250
η_{rel}	1	4.0755	3.2137	2.7269	2.4729	2.1863
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log[(\eta_{rel}-1)/c]$	-	1.3089	1.2454	1.2042	1.1766	1.1504
η	8.989					
DP	1707.865					

Table A2 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose II_I (cotton knitted fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.37	262.96	211.80	181.56	161.95	148.64
2	72.31	262.66	211.66	181.11	161.61	148.07
3	72.32	262.60	211.62	181.85	160.92	147.93
Average flow time	72.33	262.74	211.69	181.17	161.49	148.21
SD	0.0321	0.1929	0.0945	0.3592	0.5248	0.3761
η_{rel}	1	3.6325	2.9267	2.5048	2.2327	2.0491
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
$\log[(\eta_{rel}-1)/c]$	-	1.2400	1.1834	1.1433	1.1145	1.0955
η	8.143					
DP	1545.225					

Table **A3**   Raw data of solvent (t_0) and celluiose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose III_I (cotton knitted fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.11	294.13	230.6	197.10	173.42	157.51
2	72.00	293.56	229.76	196.45	172.85	157.34
3	71.99	293.19	229.09	195.78	172.81	157.15
Average flow time	72.63	293.63	229.82	196.44	173.03	157.33
SD	0.0666	0.4735	0.7566	0.6600	0.3412	0.1801
η_{rel}	1	4.0735	3.1906	2.7272	2.4022	2.1842
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log [(\eta_{rel} - 1) / c]$	-	1.3091	1.2409	1.2043	1.1718	1.1497
η	8.902					
DP	1691.428					

Table **A4**   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose III_{II} (cotton knitted fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.85	282.72	228.85	196.8	176.05	161.40
2	78.79	282.23	228.46	196.67	175.59	161.20
3	78.71	281.96	228.41	196.49	175.32	160.67
Average flow time	78.78	282.30	228.57	196.65	175.65	161.09
SD	0.0702	0.3853	0.2409	0.1557	0.3691	0.3772
η_{rel}	1	3.5834	2.9014	2.4962	2.2296	2.0448
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
$\log [(\eta_{rel} - 1) / c]$	-	1.2318	1.1777	1.1408	1.1134	1.0937
η	8.302					
DP	1577.443					

Table A5 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination
of the degree of polymerization (DP) of cellulose I from cellulose III$_1$ (cotton knitted
fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.89	301.96	241.94	205.22
2	78.90	301.90	240.66	204.08
3	78.92	300.85	239.70	203.78
Average flow time	78.90	301.57	240.77	203.93
SD	0.0153	0.6243	1.1238	0.2121
η_{rel}	1	3.8222	3.0516	2.5847
c	0	0.1500	0.0125	0.1071
log [(η_{rel} - 1) / c]	-	1.2745	1.2152	1.1702
η	8.143			
DP	1547.225			

Table A6 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination
of the degree of polymerization (DP) of cellulose I from cellulose III$_{II}$ (cotton knitted
fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	72.75	293.80	233.49	197.81
2	72.61	293.75	232.92	196.54
3	72.70	293.54	232.35	196.25
Average flow time	72.69	293.70	232.92	196.87
SD	0.0709	0.1380	0.5700	0.8297
η_{rel}	1	4.0404	3.2043	2.7084
c	0	0.1505	0.1254	0.1075
log [(η_{rel} - 1) / c]	-	1.3054	1.2450	1.2012
η	8.730			
DP	1658.646			

Table A7   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose II from cellulose III$_{II}$ (cotton knitted

fabric, single jersey, yarn count 20/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.92	280.22	225.61	193.80
2	78.88	279.98	225.58	193.32
3	78.89	279.89	224.93	193.01
Average flow time	78.90	280.03	225.37	193.38
SD	0.0208	0.1706	0.3842	0.3980
η_{rel}	1	3.5492	2.8564	2.4510
c	0	0.1520	0.1267	0.1086
$\log [(\eta_{rel} - 1) / c]$	-	1.2246	1.1659	1.1258
η	7.547			
DP	1434.015			

Table A8   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.98	310.58	247.23	210.37	187.57	170.12
2	78.88	310.50	246.23	210.32	187.56	169.78
3	78.92	309.63	245.99	210.14	186.57	169.64
Average flow time	78.93	310.24	246.48	210.28	187.23	169.85
SD	0.0503	0.5270	0.6577	0.1210	0.5745	0.2469
η_{rel}	1	3.9306	3.1228	2.6641	2.3721	2.1519
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log [(\eta_{rel} - 1) / c]$	-	1.2880	1.2272	1.1882	1.1624	1.1377
η	8.933					
DP	1697.280					

Table A9   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose II (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.20	242.48	197.41	170.64	153.41	140.94
2	72.25	242.03	196.32	170.04	153.00	140.86
3	72.28	241.98	196.56	169.90	152.56	140.59
Average flow time	72.24	242.16	196.76	170.19	152.99	140.8
SD	0.0404	0.2754	0.5727	0.3931	0.4251	0.1934
η_{rel}	1	3.3522	2.6503	2.2924	2.1178	1.9491
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log [(\eta_{rel} - 1) / c]$	-	1.1925	1.1179	1.0784	1.0734	1.0536
η	7.513					
DP	1427.426					

Table A10　Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose III_I (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.06	302.22	239.72	204.00	181.47	165.37
2	78.15	302.15	239.13	203.56	181.40	165.35
3	78.14	301.93	239.10	202.44	181.42	165.16
Average flow time	78.12	302.10	239.32	203.33	181.43	165.29
SD	0.0493	0.1513	0.3496	0.8043	0.0361	0.1159
η_{rel}	1	3.8671	3.0633	2.6028	2.3225	2.1158
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
$\log [(\eta_{rel} - 1) / c]$	-	1.2770	1.2132	1.1707	1.1450	1.1223
η	8.447					
DP	1604.921					

Table A11　Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose III_{II} (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	74.37	242.12	199.02	172.56	155.64	143.27
2	74.41	242.10	198.95	172.34	155.21	142.98
3	74.38	242.05	198.07	171.92	154.76	142.53
Average flow time	74.39	242.09	198.68	172.27	155.2	142.93
SD	0.0208	0.0301	0.5294	0.3252	0.4400	0 3729
η_{rel}	1	3.2543	2.6708	2.3158	2.0683	1.9214
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log [(\eta_{rel} - 1) / c]$	-	1.1740	1.1232	1.0862	1.0610	1.0407
η	7.463					
DP	1417.926					

Table A12   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_\text{I}$ (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.99	300.98	241.24	205.61
2	78.97	300.76	241.18	205.43
3	78.97	300.50	241.09	205.26
Average flow time	78.97	300.75	241.16	205.43
SD	0.0115	0.2403	0.0650	0.1750
η_{rel}	1	3.8084	3.0538	2.6014
c	0	0.1500	0.1250	0.1071
$\log [\,(\eta_{rel}-1)/c\,]$	-	1.2724	1.2156	1.1747
η	8.529			
DP	1620.517			

Table A13   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_\text{II}$ (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	72.64	310.62	247.35	212.97
2	72.60	309.74	247.21	211.41
3	72.59	309.46	246.98	210.91
Average flow time	72.61	309.94	247.18	211.76
SD	0.0265	0.6053	0.1868	1.0744
η_{rel}	1	4.2686	3.4042	2.9164
c	0	0.1505	0.1254	0.1075
$\log [\,(\eta_{rel}-1)/c\,]$	-	1.3368	1.8227	1.2011
η	7.560			
DP	1436.328			

Table A14 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose II from cellulose III$_{II}$ (cotton knitted fabric, single jersey, yarn count 50/1)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	72.76	273.47	223.29	187.46
2	72.73	272.88	223.20	186.64
3	72.69	272.65	222.50	186.34
Average flow time	72.73	273.00	223.00	186.81
SD	0.0351	0.4230	0.4325	0.5798
η_{rel}	1	3.7536	3.0661	2.5685
c	0	0.1500	0.1250	0.1071
$\log[(\eta_{rel}-1)/c]$	-	1.2638	1.2182	1.1657
η	8.480			
DP	1611.215			

Table A15 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose I (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)				
	t_0	t_1	t_2	t_3	t_4
1	72.25	267.90	220.50	191.21	171.21
2	72.12	265.77	219.51	190.82	170.75
3	72.15	264.50	217.97	190.42	170.21
Average flow time	72.17	266.06	219.37	190.82	170.72
SD	0.0681	1.7180	1.2749	0.3950	0.5005
η_{rel}	1	3.6866	3.0396	2.6440	2.3655
c	0	0.1500	0.1250	0.1071	0.0938
log [(η_{rel} - 1) / c]	-	1.2531	1.2126	1.1861	1.1631
η	10.344				
DP	1965.411				

Table A16 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose II_I (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.86	282.66	228.95	196.82	176.06	161.38
2	78.77	282.35	228.46	196.75	176.66	160.71
3	78.71	282.03	228.44	196.55	175.39	160.62
Average flow time	78.78	282.35	228.62	196.71	176.04	160.90
SD	0.0603	0.3150	0.2889	0.1401	0.6353	0.4153
η_{rel}	1	3.5840	2.9020	2.4970	2.2346	2.0424
c	0	0.1515	0.1263	1.1082	0.0947	0.0842
log [(η_{rel} - 1) / c]	-	1.2319	1.1778	1.1410	1.1152	1.0927
η	8.306					
DP	1578.169					

Table A17 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose III$_1$ (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.38	264.25	218.62	191.69	170.15	156.00
2	72.23	262.72	217.81	191.02	170.13	155.62
3	72.22	262.94	216.56	190.10	170.10	155.31
Average flow time	72.28	263.30	217.66	190.94	170.136	155.64
SD	0.0896	0.8272	1.0378	0.7983	0.0252	0.3456
η_{rel}	1	3.6428	3.0113	2.6417	2.3538	2.1533
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
log [(η_{rel} - 1) / c]	-	1.2038	1.2038	1.1823	1.1566	1.1382
η	10.266					
DP	1950.534					

Table A18 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose III$_{II}$ (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.84	282.61	228.90	196.77	176.01	161.33
2	78.78	282.30	228.41	196.70	175.61	160.66
3	78.72	281.98	228.39	196.50	175.34	160.57
Average flow time	78.78	282.30	228.57	196.66	175.65	160.85
SD	0.0600	0.3150	0.2889	0.1401	0.3371	0.4153
η_{rel}	1	3.5834	2.9014	2.4963	2.2296	2.0418
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
log [(η_{rel} - 1) / c]	-	1.2318	1.1777	1.1408	1.1134	1.0925
η	8.2699					
DP	1571.280					

83

Table A19 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_I$ (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.85	321.12	254.41	216.92
2	78.82	320.60	253.96	216.07
3	78.76	319.96	252.80	215.79
Average flow time	78.81	320.56	253.72	216.26
SD	0.0458	0.5810	0.8307	0.5885
η_{rel}	1	4.0675	3.2194	2.7441
c	0	0.1520	0.1267	0.1086
$\log[(\eta_{rel}-1)/c]$	-	1.3049	1.2435	1.2057
η	9.018			
DP	1713.38			

Table A20 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_{II}$ (cotton woven fabric, plain structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.85	301.41	240.53	204.28
2	78.84	300.95	240.25	204.09
3	78.86	300.09	239.84	203.87
Average flow time	78.85	300.82	240.21	204.08
SD	0.0100	0.6700	0.3470	0.2052
η_{rel}	1	3.8151	3.0464	2.5882
c	0	0.1500	0.1250	0.1071
$\log[(\eta_{rel}-1)/c]$	-	1.2734	1.2141	1.1711
η	8.239			
DP	1565.502			

Table A21 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination
of the degree of polymerization (DP) of cellulose II from cellulose III_{II} (cotton woven
fabric, plain structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.91	280.36	225.78	193.9
2	78.90	280.29	225.63	193.59
3	78.89	280.26	225.51	193.47
Average flow time	78.90	280.30	225.64	193.65
SD	0.0010	0.0513	0.1353	0.2219
η_{rel}	1	3.5526	2.8598	2.4544
c	0	0.1520	0.1267	0.1086
$\log [(\eta_{rel} - 1) / c]$	-	1.2251	1.1667	1.1269
η	7.593			
DP	1442.626			

Table A22   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.25	296.28	232.65	199.20	176.35	160.23
2	72.20	296.15	232.55	199.07	176.29	160.10
3	72.09	296.03	232.41	198.97	176.13	159.88
Average flow time	72.18	296.15	232.54	199.08	176.26	160.67
SD	0.0819	0.125	0.1206	0.1153	0.1137	0.1769
η_{rel}	1	4.1029	3.2217	2.7581	2.4420	2.2176
c	0	0.1510	0.1258	0.1079	0.0944	0.0839
$\log [(\eta_{rel} - 1) / c]$	-	1.3128	1.2470	1.2120	1.1840	1.1617
η	9.397					
DP	1785.474					

Table A23   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose II_I (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.84	282.68	228.83	196.78	175.98	161.35
2	78.80	282.22	228.48	196.67	175.62	161.26
3	78.70	282.08	228.41	196.50	175.53	160.71
Average flow time	78.78	282.33	228.57	196.65	175.71	161.11
SD	0.0721	0.3139	0.2250	0.1411	0.2381	0.3465
η_{rel}	1	3.5838	2.9014	2.4962	2.2303	2.0451
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
$\log [(\eta_{rel} - 1) / c]$	-	1.2318	1.1777	1.1408	1.1132	1.0938
η	8.310					
DP	1578.896					

Table A24 Raw data of solvent (t_o) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose III_I (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	78.82	302.23	242.67	207.29	184.69	168.28
2	78.90	301.90	242.24	206.92	184.60	168.07
3	78.89	301.85	242.09	208.90	183.96	167.88
Average flow time	78.87	301.99	242.33	207.04	184.42	168.08
SD	0.0436	0.2065	0.3011	0.2196	0.3980	0.2000
η_{rel}	1	3.8290	3.0725	2.6251	2.3383	2.1311
c	0	0.1500	0.1250	0.1071	0.0938	0.0833
$\log [(\eta_{rel} - 1) / c]$	-	1.2755	1.2196	1.1811	1.1544	1.1329
η	8.989					
DP	1707.865					

Table A25 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination

of the degree of polymerization (DP) of cellulose III_{II} (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)					
	t_0	t_1	t_2	t_3	t_4	t_5
1	72.39	262.97	211.79	181.57	161.97	148.61
2	72.31	262.63	211.66	181.10	161.60	148.09
3	72.26	262.59	211.64	180.83	160.95	148.05
Average flow time	72.32	262.73	211.70	181.17	161.51	148.25
SD	0.0656	0.2088	0.0815	0.3745	0.5164	0.3124
η_{rel}	1	3.6329	2.9273	2.5051	2.2333	2.0499
c	0	0.1515	0.1263	0.1082	0.0947	0.0842
$\log [(\eta_{rel} - 1) / c]$	-	1.2400	1.1835	1.1433	1.1147	1.0958
η	8.155					
DP	1549.365					

Table A26   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_I$ (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	78.93	287.80	233.39	201.18
2	78.85	287.71	232.69	200.47
3	78.73	287.52	231.95	199.78
Average flow time	78.83	287.68	232.68	200.48
SD	0.1007	0.1430	0.7201	0.7000
η_{rel}	1	3.6494	2.9517	2.5432
c	0	0.1510	0.1258	0.1079
log [(η_{rel} - 1) / c]	-	1.2442	1.1907	1.1554
η	8.551			
DP	1624.627			

Table A27   Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose I from cellulose III$_{II}$ (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	72.79	283.04	227.26	193.97
2	72.70	282.93	226.45	193.48
3	72.68	282.29	225.46	193.03
Average flow time	72.72	282.75	226.39	193.49
SD	0.0586	0.4050	0.9015	0.4701
η_{rel}	1	3.8882	3.1132	2.6608
c	0	0.151	0.1258	0.1079
log [(η_{rel} - 1) / c]	-	1.2817	1.2253	1.1873
η	8.917			
DP	1694.157			

Table A28 Raw data of solvent (t_0) and cellulose solution (t_n) flow times for the determination of the degree of polymerization (DP) of cellulose II from cellulose III$_{II}$ (cotton woven fabric, satin structure)

Trial No.	Flow Times (sec.)			
	t_0	t_1	t_2	t_3
1	72.72	293.69	232.89	196.38
2	72.68	293.47	232.47	196.25
3	72.69	293.40	232.21	196.11
Average flow time	72.70	293.52	232.52	196.25
SD	0.0208	0.1513	0.3431	0.1351
η_{rel}	1	4.0374	3.1983	2.6994
c	0	0.1500	0.1250	0.1071
$\log [(\eta_{rel} - 1) / c]$	-	1.3064	1.2452	1.2005
η	8.640			
DP	1641.548			

Table A29   Raw data of breaking load (N) along warp direction of cotton woven fabric with plain

structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Breaking Load (N)			Average	SD.	CV.
	trial 1	trial 2	trial 3			
Cellulose I (Native cellulose)	381.633	376.904	348.573	369.037	14.598	3.956
Cellulose I from Cellulose III_I	398.067	376.656	376.171	383.631	10.209	2.661
Cellulose I from Cellulose III_{II}	438.597	415.139	444.206	432.647	12.590	2.910
Cellulose II_I	500.808	531.811	489.367	507.329	17.931	3.534
Cellulose II from Cellulose III_{II}	453.059	466.534	452.505	457.366	6.487	1.418
Cellulose III_I	440.093	450.532	458.299	449.641	7.459	1.659
Cellulose III_{II}	554.159	532.324	521.593	536.025	13.550	2.528

Table A30   Raw data of breaking load (N) along weft direction of cotton woven fabric with plain

structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Breaking Load (N)			Average	SD.	CV.
	trial 1	trial 2	trial 3			
Cellulose I (Native cellulose)	230.226	237.059	224.300	230.528	5.213	2.261
Cellulose II_I	381.149	393.875	370.223	381.749	9.665	2.532
Cellulose III_I	329.423	329.960	318.892	326.092	5.096	1.563
Cellulose III_{II}	418.190	420.439	414.717	417.782	2.354	0.563
Cellulose I from Cellulose III_I	276.527	281.148	271.935	276.537	3.761	1.360
Cellulose I from Cellulose III_{II}	336.116	355.758	340.285	344.053	8.450	2.456
Cellulose II from Cellulose III_{II}	353.027	375.763	362.788	365.059	10.387	2.845

Table A31   Raw data of breaking load (N) along warp direction of cotton woven fabric with satin
structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Breaking Load (N)			Average	SD.	CV.
	trial 1	trial 2	trial 3			
Cellulose I (Native Cellulose)	926.374	941.294	941.697	936.455	7.130	0.761
Cellulose I from Cellulose III$_I$	964.944	1002.184	987.799	984.976	15.334	1.557
Cellulose I from Cellulose III$_{II}$	1045.517	1053.341	1041.478	1046.779	4.925	0.470
Cellulose II$_I$	1195.732	1188.594	1174.029	1186.118	9.031	0.761
Cellulose II from Cellulose III$_{II}$	1136.468	1146.418	1112.692	1131.859	14.149	1.250
Cellulose III$_I$	1108.393	1076.607	1115.135	1100.045	16.800	1.527
Cellulose III$_{II}$	1347.174	1336.937	1353.778	1345.963	6.928	0.515

Table A32   Raw data of breaking load (N) along weft direction of cotton woven fabric with satin
structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Breaking Load (N)			Average	SD.	CV.
	trial 1	trial 2	trial 3			
Cellulose I (Native Cellulose)	522.404	514.858	523.772	520.345	3.920	0.753
Cellulose I from Cellulose III$_I$	644.450	617.178	610.852	624.160	14.578	2.336
Cellulose I from Cellulose III$_{II}$	742.126	749.301	751.130	747.519	3.886	0.520
Cellulose II$_I$	830.393	838.431	868.482	845.769	16.393	1.938
Cellulose II from Cellulose III$_{II}$	774.306	790.263	757.268	773.766	16.498	2.132
Cellulose III$_I$	652.475	654.297	640.598	649.123	6.074	0.936
Cellulose III$_{II}$	887.168	877.823	840.725	868.572	20.057	2.309

Table A33 Raw data of elongation along warp direction of cotton woven fabric with plain structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Elongation (%)			Average	SD.	CV.
	Trial 1	Trial 2	Trial 3			
Cellulose I (Native Cellulose)	7.417	7.503	6.670	7.197	0.374	5.198
Cellulose I from Cellulose III$_I$	32.755	34.420	31.667	32.947	1.132	3.436
Cellulose I from Cellulose III$_{II}$	45.252	45.335	45.750	45.446	0.218	0.479
Cellulose II$_I$	35.252	35.585	35.837	35.558	0.240	0.674
Cellulose II from Cellulose III$_{II}$	48.420	48.752	47.502	48.225	0.529	1.096
Cellulose III$_I$	33.420	33.003	32.920	33.114	0.219	0.661
Cellulose III$_{II}$	44.420	43.170	43.003	43.531	0.632	1.453

Table A34 Raw data of elongation along weft direction of cotton woven fabric with plain structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Elongation (%)			Average	SD.	CV.
	Trial 1	Trial 2	Trial 3			
Cellulose I (Native Cellulose)	15.167	14.503	13.835	14.502	0.544	3.750
Cellulose I from Cellulose III$_I$	22.170	23.920	23.502	23.197	0.746	3.217
Cellulose I from Cellulose III$_{II}$	28.000	28.085	28.333	28.139	0.141	0.502
Cellulose II$_I$	23.170	23.668	22.587	23.142	0.442	1.909
Cellulose II from Cellulose III$_{II}$	27.500	27.418	26.252	27.057	0.570	2.107
Cellulose III$_I$	22.668	22.750	22.918	22.779	0.104	0.457
Cellulose III$_{II}$	26.335	27.000	25.833	26.389	0.478	1.811

Table A35 Raw data of elongation along warp direction of cotton woven fabric with satin structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Elongation (%)			Average	SD.	CV.
	Trial 1	Trial 2	Trial 3			
Cellulose I (Native Cellulose)	9.667	9.837	9.505	9.670	0.136	1.402
Cellulose I from Cellulose III_I	30.250	31.253	30.918	30.807	0.417	1.353
Cellulose I from Cellulose III_{II}	39.503	39.837	39.917	39.752	0.179	0.451
Cellulose II	37.500	39.587	45.670	40.919	3.466	8.470
Cellulose II from Cellulose III_{II}	45.752	45.503	44.000	45.085	0.774	1.717
Cellulose III_I	28.333	30.168	30.002	29.501	0.829	2.809
Cellulose III_{II}	42.750	42.917	42.003	42.557	0.397	0.934

Table A36 Raw data of elongation along weft direction of cotton woven fabric with satin structure at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Elongation (%)			Average	SD.	CV.
	Trial 1	Trial 2	Trial 3			
Cellulose I (Native Cellulose)	14.753	14.837	14.835	14.808	0.039	0.264
Cellulose I from Cellulose III_I	22.583	23.002	22.835	22.807	0.172	0.755
Cellulose I from Cellulose III_{II}	27.920	27.167	27.667	27.585	0.313	1.134
Cellulose II_I	23.835	23.833	23.837	23.835	0.002	0.007
Cellulose II from Cellulose III_{II}	27.835	27.587	26.503	27.308	0.578	2.118
Cellulose III_I	23.587	22.753	22.837	23.059	0.375	1.626
Cellulose III_{II}	27.585	27.333	27.417	27.445	0.105	0.382

Table A37 Raw data of bursting strength of cotton knitted fabric with single jersey structure and yarn count 50/1 at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Bursting Strength (kPa.)										Average	SD.	CV.
	1	2	3	4	5	6	7	8	9	10			
Cellulose I (Native Cellulose)	783	704	723	731	747	758	786	722	712	740	740.60	26.66	3.60
Cellulose I from Cellulose III$_I$	808	808	776	765	810	794	773	820	795	793	794.20	17.12	2.16
Cellulose I from Cellulose III$_{II}$	887	891	896	893	897	868	883	875	864	851	880.50	14.69	1.67
Cellulose II$_I$	827	867	866	826	831	867	810	823	891	835	844.30	24.92	2.95
Cellulose II from Cellulose III$_{II}$	876	882	845	890	922	871	848	921	851	871	877.70	26.01	2.96
Cellulose III$_I$	795	825	803	784	809	795	785	821	826	842	808.60	18.54	2.29
Cellulose III$_{II}$	908	865	880	864	888	865	907	865	883	889	881.40	16.06	1.82

Table A38 Raw data of bursting strength of cotton knitted fabric with single jersey structure and yarn count 20/1 at various stages of cellulose polymorphs.

Stage of Cellulose Polymorph	Bursting Strength (kPa.)										Average	SD.	CV.
	1	2	3	4	5	6	7	8	9	10			
Cellulose I (Native Cellulose)	1105	1148	1144	1054	1057	1100	1109	1105	1111	1156	1108.9	32.9	3.0
Cellulose I from Cellulose III$_I$	1212	1230	1220	1276	1270	1244	1230	1236	1252	1279	1244.9	22.4	1.8
Cellulose I from Cellulose III$_{II}$	1426	1420	1389	1415	1397	1357	1370	1393	1390	1369	1392.6	21.8	1.6
Cellulose II$_I$	1312	1365	1337	1261	1325	1323	1251	1291	1330	1262	1305.8	36.1	2.8
Cellulose II from Cellulose III$_{II}$	1360	1401	1369	1379	1350	1357	1412	1336	1384	1391	1373.9	22.6	1.6
Cellulose III$_I$	1376	1279	1244	1175	1326	1237	1330	1274	1235	1293	1276.9	54.9	4.3
Cellulose III$_{II}$	1389	1396	1481	1343	1424	1455	1430	1413	1425	1438	1419.4	35.9	2.5

BIOGRAPHY

Miss. Wilaiporn Sottithumaruk was born in Bangkok, Thailand, on March 24, 1976. She received a Bachelor degree with a major in polymer science from the Faculty of Science, Chulalongkorn University in 1997. She started as a graduate student in the Department of Materials Science with a major in Applied Polymer Science and Textile Technology, Faculty of Science, Chulalongkorn University in May 1998, and completed the program in May 2001.