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ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



Appendix

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

A1. Data for Grafting Terms of Starch-*g*-styrene Copolymerization which Using the Starch Pre-gel and Adding the Initiator at Room Temperature

	The Values of Grafting Terms				
	X1	X2	X3	mean	SD
% add on	28.25	29.13	28.04	28.47	0.47
% conversion of monomer	95.94	97.83	97.01	96.93	0.77
% homopolymer formation	61.58	61.25	62.46	61.76	0.51
% Grafting Efficiency	38.42	38.75	37.54	38.24	0.51
% Grafting Ratio	36.83	37.90	36.40	37.04	0.63
% Yield	86.20	86.42	86.63	86.42	0.17

A2. Data for Grafting Terms of Starch-*g*-styrene Copolymerization which Using the Starch Pre-gel and Adding the Initiator at Pre-gel Temperature

	The Values of Grafting Terms				
	X1	X2	X3	mean	SD
% add on	20.09	20.42	20.97	20.49	0.36
% conversion of monomer	82.34	83.92	84.09	83.45	0.77
% homopolymer formation	70.14	70.08	69.09	69.77	0.48
% Grafting Efficiency	29.86	29.92	30.91	30.23	0.48
% Grafting Ratio	24.58	25.10	25.98	25.22	0.58
% Yield	82.72	82.50	83.04	82.75	0.22

A3. Data for Grafting Terms of Starch-*g*-styrene Copolymerization which Mixed all the Raw Materials at the Same Time

	The Values of Grafting Terms				
	X1	X2	X3	mean	SD
% add on	25.54	26.07	25.67	25.76	0.22
% conversion of monomer	94.84	94.08	93.76	94.23	0.45
% homopolymer formation	66.12	64.91	64.81	65.28	0.59
% Grafting Efficiency	33.88	35.09	35.19	34.72	0.59
% Grafting Ratio	32.11	33.01	32.97	32.70	0.41
% Yield	85.74	85.42	86.09	85.75	0.27

A4. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 0.01 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	mean	SD
% add on	4.24	3.77	4.40	4.14	0.27
% conversion of monomer	55.38	53.78	58.54	55.9	1.98
% homopolymer formation	92.33	92.96	92.47	92.59	0.27
% Grafting Efficiency	7.67	7.04	7.53	7.41	0.27
% Grafting Ratio	4.24	3.78	4.39	4.14	0.26
% Yield	75.49	74.96	76.99	75.81	0.86

A5. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Monomer Concentration at 0.05 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	15.49	17.08	18.99	17.19	1.43
% conversion of monomer	59.77	64.67	63.88	62.77	2.15
% homopolymer formation	70.25	70.09	65.44	68.59	2.23
% Grafting Efficiency	29.75	29.91	34.56	31.41	2.23
% Grafting Ratio	17.76	19.34	22.07	19.72	1.78
% Yield	77.97	78.69	78.53	78.40	0.30

A6. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Monomer Concentration at 0.1 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	31.83	31.64	30.11	31.19	0.77
% conversion of monomer	87.15	88.23	86.65	87.34	0.66
% homopolymer formation	51.79	52.20	54.13	52.71	1.02
% Grafting Efficiency	48.21	47.80	45.87	47.29	1.02
% Grafting Ratio	42.01	42.14	39.74	41.30	1.10
% Yield	87.69	88.31	88.41	88.14	0.32

A7. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 0.2 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	32.65	32.93	31.86	32.48	0.45
% conversion of monomer	87.90	88.97	87.46	88.11	0.63
% homopolymer formation	50.11	50.46	51.03	50.53	0.38
% Grafting Efficiency	49.89	49.54	48.97	49.47	0.38
% Grafting Ratio	43.78	44.06	42.81	43.55	0.53
% Yield	87.24	87.67	87.71	87.54	0.21

A8. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 0.3 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	33.63	33.99	32.42	33.35	0.67
% conversion of monomer	91.79	92.38	92.19	92.10	0.26
% homopolymer formation	49.87	49.97	52.29	50.71	1.12
% Grafting Efficiency	50.13	50.03	47.71	49.29	1.12
% Grafting Ratio	46.01	46.22	43.92	45.38	1.04
% Yield	88.36	88.47	89.26	88.70	0.40

A9 Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 0.4 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	32.15	34.13	35.81	34.03	1.49
% conversion of monomer	89.65	92.67	95.93	92.75	2.56
% homopolymer formation	49.42	49.02	48.13	48.86	0.54
% Grafting Efficiency	50.58	50.98	51.87	51.14	0.54
% Grafting Ratio	45.32	47.23	49.75	47.43	1.81
% Yield	89.03	88.23	88.87	88.71	0.34

A10. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 0.5 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	36.17	35.99	35.45	35.87	0.30
% conversion of monomer	95.24	97.44	94.19	95.64	1.37
% homopolymer formation	42.82	49.15	46.30	46.09	2.59
% Grafting Efficiency	57.18	50.85	53.70	53.91	2.59
% Grafting Ratio	53.95	49.57	50.25	51.26	1.92
% Yield	87.31	88.80	88.14	88.08	0.61

A11. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 1.0 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	29.11	27.83	27.90	28.28	0.59
% conversion of monomer	97.66	96.36	95.95	96.56	0.73
% homopolymer formation	61.19	62.66	62.01	61.95	0.60
% Grafting Efficiency	38.81	37.34	37.99	38.04	0.60
% Grafting Ratio	37.89	35.98	36.41	36.76	0.82
% Yield	86.35	86.33	86.43	86.37	0.04

A12. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 1.5 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	21.24	19.81	19.63	20.23	0.72
% conversion of monomer	112.75	101.50	104.21	106.15	4.79
% homopolymer formation	77.91	76.54	76.98	77.14	0.57
% Grafting Efficiency	22.09	23.46	23.02	22.86	0.57
% Grafting Ratio	24.90	23.81	24.00	24.24	0.47
% Yield	89.04	86.04	87.94	87.67	1.24

A13. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Monomer Concentration at 2.0 g of BPO

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	17.37	14.71	-	16.04	1.33
% conversion of monomer	119.75	112.15	-	115.95	3.80
% homopolymer formation	84.15	84.47	-	84.31	0.16
% Grafting Efficiency	15.85	15.53	-	15.69	0.16
% Grafting Ratio	20.17	17.42	-	18.80	1.37
% Yield	89.88	88.90	-	89.39	0.49

A14. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Reaction Time at 1 Hour

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	29.22	30.02	28.53	29.26	0.61
% conversion of monomer	40.25	39.98	35.13	39.79	0.48
% homopolymer formation	51.09	54.08	53.25	52.80	1.26
% Grafting Efficiency	48.91	45.92	46.75	47.19	1.26
% Grafting Ratio	40.23	39.99	39.07	39.76	0.50
% Yield	85.64	85.79	86.49	85.97	0.37

A15. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Reaction Time at 3 Hour

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	33.03	33.56	32.64	33.08	0.38
% conversion of monomer	87.13	89.72	91.80	89.55	1.91
% homopolymer formation	49.25	48.11	52.21	49.86	1.73
% Grafting Efficiency	50.75	51.89	47.79	50.14	1.73
% Grafting Ratio	44.21	46.53	43.86	44.87	1.18
% Yield	86.69	86.62	86.74	86.68	0.05

A16. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Reaction Temperature at 70°C

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	22.31	21.00	24.17	22.49	1.30
% conversion of monomer	75.92	76.98	80.28	77.73	1.86
% homopolymer formation	62.85	65.68	61.57	63.36	1.72
% Grafting Efficiency	37.15	34.32	38.43	36.63	1.72
% Grafting Ratio	28.20	26.41	30.81	28.47	1.81
% Yield	82.91	84.00	84.14	83.68	0.55

A17. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Reaction Temperature at 90°C

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	30.07	32.26	33.04	31.79	1.26
% conversion of monomer	90.16	91.32	94.86	92.11	2.00
% homopolymer formation	55.62	50.95	53.33	53.3	1.91
% Grafting Efficiency	44.38	49.05	46.67	46.7	1.91
% Grafting Ratio	39.97	44.74	44.27	42.99	2.15
% Yield	87.11	88.03	87.95	87.70	0.42

A18. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 1 g of Starch : 9 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	22.67	24.73	23.72	23.71	0.84
% conversion of monomer	72.74	73.61	73.21	73.19	0.35
% homopolymer formation	95.58	95.10	95.28	95.32	0.20
% Grafting Efficiency	4.42	4.90	4.72	4.68	0.20
% Grafting Ratio	28.84	32.40	31.00	30.75	1.46
% Yield	71.71	72.41	72.32	72.19	0.31

A19. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 2 g of Starch : 8 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	29.60	28.16	31.55	29.77	1.39
% conversion of monomer	68.66	70.95	68.49	69.37	1.13
% homopolymer formation	84.75	86.25	83.30	84.77	1.20
% Grafting Efficiency	15.25	13.75	16.70	15.23	1.20
% Grafting Ratio	41.80	38.98	45.61	42.13	2.72
% Yield	71.30	73.01	71.00	71.77	0.88

A20. Data for Grafting Terms of Starch-g-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 3 g of Starch : 7 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	37.42	37.00	36.12	36.85	0.54
% conversion of monomer	77.39	79.67	75.69	77.58	1.63
% homopolymer formation	68.07	69.74	69.25	69.02	0.70
% Grafting Efficiency	31.93	30.26	30.75	30.98	0.70
% Grafting Ratio	57.64	56.22	54.20	56.02	1.41
% Yield	79.24	50.50	77.86	79.20	1.08

A21. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 4 g of Starch : 6 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	34.63	35.99	36.59	35.74	0.82
% conversion of monomer	75.30	80.11	81.87	79.09	2.78
% homopolymer formation	53.69	53.31	53.23	53.41	0.20
% Grafting Efficiency	46.31	46.69	46.77	46.59	0.20
% Grafting Ratio	52.29	56.09	57.42	55.27	2.28
% Yield	80.59	83.68	84.72	83.00	1.75

A22. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 6 g of Starch : 4 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	23.98	25.33	26.38	25.23	0.98
% conversion of monomer	97.34	96.81	99.93	98.03	1.36
% homopolymer formation	51.43	48.27	47.70	49.13	1.64
% Grafting Efficiency	48.57	51.73	52.3	50.87	1.64
% Grafting Ratio	31.54	33.38	34.84	33.25	1.35
% Yield	93.73	93.01	93.50	93.41	0.30

A23. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 7 g of Starch : 3 g of Styrene Monomer

	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	17.29	17.07	16.60	16.99	0.29
% conversion of monomer	95.41	97.68	97.41	96.83	1.01
% homopolymer formation	49.08	50.99	52.46	50.84	1.38
% Grafting Efficiency	50.92	49.01	47.54	49.16	1.38
% Grafting Ratio	20.84	20.51	19.86	20.40	0.41
% Yield	93.57	94.45	94.59	94.20	0.45

A24. Data for Grafting Terms of Starch-*g*-styrene Copolymerization: Effects of Ratio of Starch and Styrene Monomer at 8 g of Starch : 2 g of Styrene Monomer

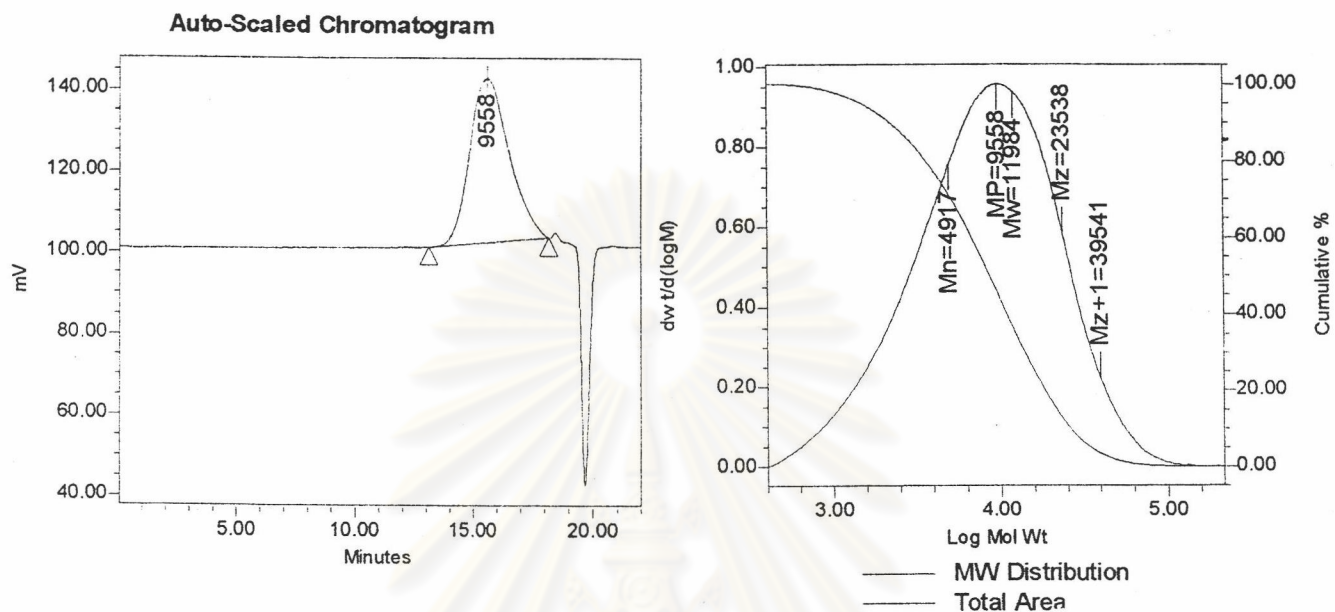
	The Values of Grafting Terms				
	X1	X2	X3	Mean	SD
% add on	10.06	10.83	10.77	10.55	0.35
% conversion of monomer	101.19	98.94	97.03	99.05	1.70
% homopolymer formation	56.03	50.57	50.38	52.46	2.53
% Grafting Efficiency	43.97	49.03	49.62	47.54	2.53
% Grafting Ratio	11.14	12.14	12.05	11.78	0.45
% Yield	95.17	94.88	94.06	94.70	0.47

A 25. Data for Moisture Absorption of Starch and Its Grafted Copolymers

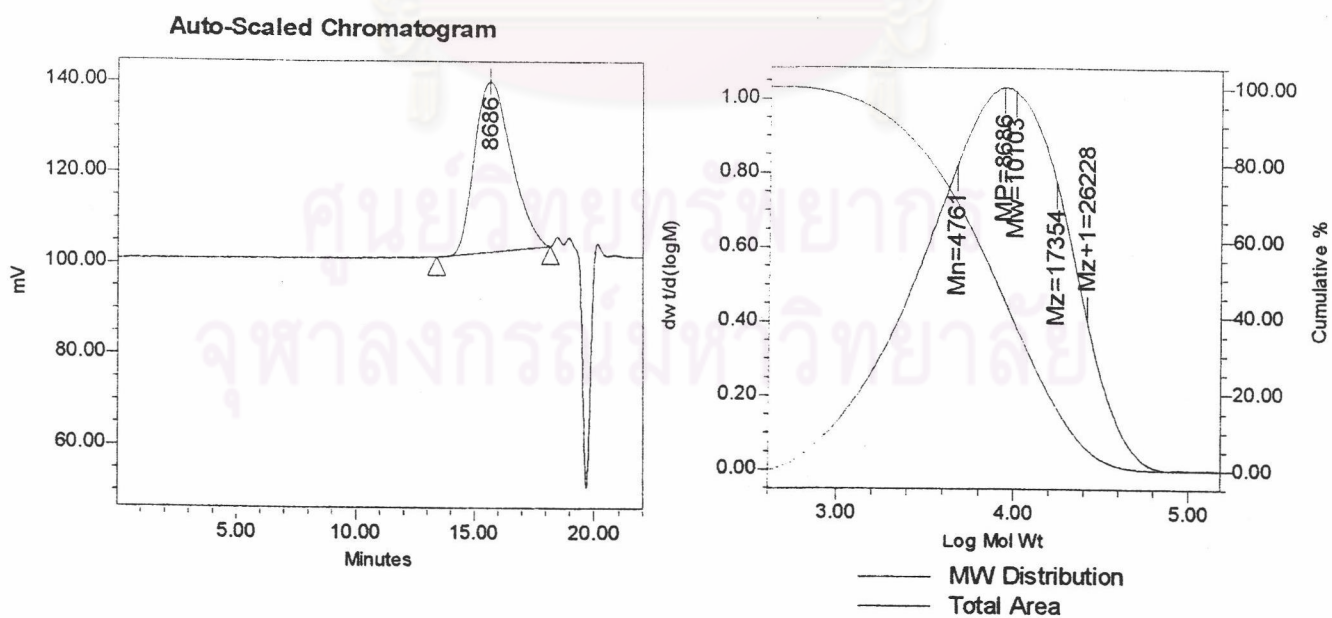
Time (hours)	Moisture Absorption(%)				
	Starch Powder	Gel Starch	Polystyrene	Starch-g-styrene Copolymer with Homopoly styrene	Starch-g-styrene Copolymer without homopolystyrene
0	0	0	0	0	0
1	4.82	4.65	0.55	2.85	5.46
2	6.27	5.98	1.14	3.16	5.99
3	8.40	8.43	0.851	4.38	7.91
4	10.54	9.75	0.71	4.95	8.78
5	12.79	11.30	0.77	5.82	9.81
6	13.72	12.06	0.74	5.95	9.72
7	14.31	12.48	1.01	6.12	10.15
8	15.64	13.04	0.99	6.48	10.42
24	26.51	27.44	1.26	16.73	23.89
48	26.28	34.79	1.14	20.42	29.38
72	26.45	39.99	0.98	20.94	31.83
96	26.54	43.62	0.86	23.14	34.75
120	26.59	44.33	1.05	22.91	35.73

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B 1. Figure of GPC chromatogram of homopolystyrene formed in starch-*g*-polystyrene copolymerization.



B 2. Figure of GPC of chromatogram of grafted polystyrene formed in starch-*g*-polystyrene copolymerization.



VITA

Mr. Weeradech Kiratitanavit was born in Bangkok, Thailand, on October 9, 1976. He received a Bachelor of Science degree with a major in Petrochemicals and Polymeric Materials from Silpakorn University in 1999. He started as a graduate student in Department of Materials Science with a major in Applied Polymer Science and Textile Technology, Chulalongkorn University in June 1999, and completed the programme in March 2002.



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