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APPENDICES

Appendix A Point of zero charge.

Preparation:

1. 0.001% W/V NR solution 500 mL

1% W/V of NR solution 0.5 mL was diluted with water to get 0.001%W/V NR solution 500 mL in the volumetric flask.

Calculation

$$c_1v_1 = c_2v_2$$

$$0.001(500) = 1(x)$$

$$x = 0.001 \times 500$$

$$x = 0.5mL$$

2. Adjust the pH of 0.001% W/V NR solution.

The flasks of 0.001% W/V NR solution was adjusted to the pH of 2, 2.5, 3, 4 and 5 by NaOH and HCl solutions. The pH meter was used for measuring the values of pH.

Procedure:

The electrophoretic mobility of the sample was measured by Zeta meter 3.0+

Results:

Table A1. Electrophoretic mobility of NR solution at different pH.

pH	Electrophoretic mobility (micron-cm./volts-sec)										SUM	AV
	1	2	3	4	5	6	7	8	9	10		
5.08	-2.33	-2.54	-2.97	-3.20	-3.55	-2.95	-3.40	-3.49	-2.19	-2.05	-28.67	-2.87
4.01	-2.04	-3.19	-1.91	-2.53	-2.21	-2.45	-2.03	-2.37	-2.18	-2.41	-23.32	-2.33
3.02	1.96	1.37	1.21	0.55	0.62	0.93	0.53	0.54	1.29	1.03	10.01	1.00
2.50	3.16	3.06	2.49	2.83	2.38	2.34	2.82	3.28	2.58	2.99	27.93	2.79
1.99	1.80	2.28	2.83	1.93	2.69	2.30	3.82	2.68	4.50	4.31	29.13	2.91

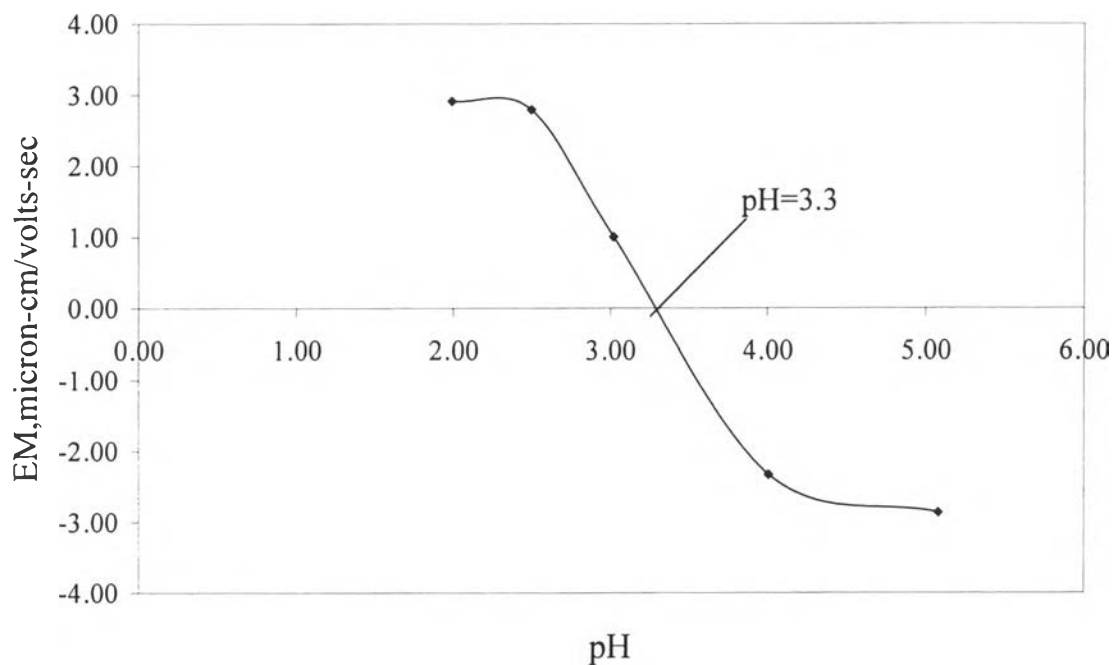


Figure A1 The electrophoretic mobility of NR particles in water at various pH.

Appendix B Study of the effect of salt on the critical micelle concentration.

Preparation:

1. 10000 μM CTAB

0.9111 g CTAB was weighed and dissolved by water pH 8 in volumetric flask 250 mL.

Calculation

$$\begin{aligned}\frac{10000 \times 10^{-6} \text{ mol}}{1000 \text{ mL}} &= \frac{x \text{ mol}}{250 \text{ mL}} \\ x \text{ mol} &= 2500 \times 10^{-6} \text{ mol} \\ &= 2500 \times 10^{-6} \times 364.45 \\ &= 0.9111 \text{ g}\end{aligned}$$

2. 0.05 M NaBr and 2.2 M NaBr

Calculation

$$\begin{aligned}\frac{0.05 \text{ mol}}{1000 \text{ mL}} &= \frac{x \text{ mol}}{25 \text{ mL}} \\ x \text{ mol} &= 0.00125 \text{ mol} \\ &= 0.00125 \times 102.89 \\ &= 0.1286 \text{ g}\end{aligned}$$

$$\begin{aligned}\frac{2.2 \text{ mol}}{1000 \text{ mL}} &= \frac{x \text{ mol}}{25 \text{ mL}} \\ x \text{ mol} &= 0.055 \text{ mol} \\ &= 0.055 \times 102.89 \\ &= 5.65895 \text{ g}\end{aligned}$$

Procedure:

1. The surfactant solution was prepared in volumetric flask 25mL by varying surfactant concentration of each bottle. 10000 μM CTAB was pipetted as showed in Table B1.
2. All bottles of surfactant contained a constant amount of NaBr. Five experiments were set by varying the concentration of salt to study the effect of salt on critical micelle concentration.
3. The surface tension of each sample was determined by DSA.

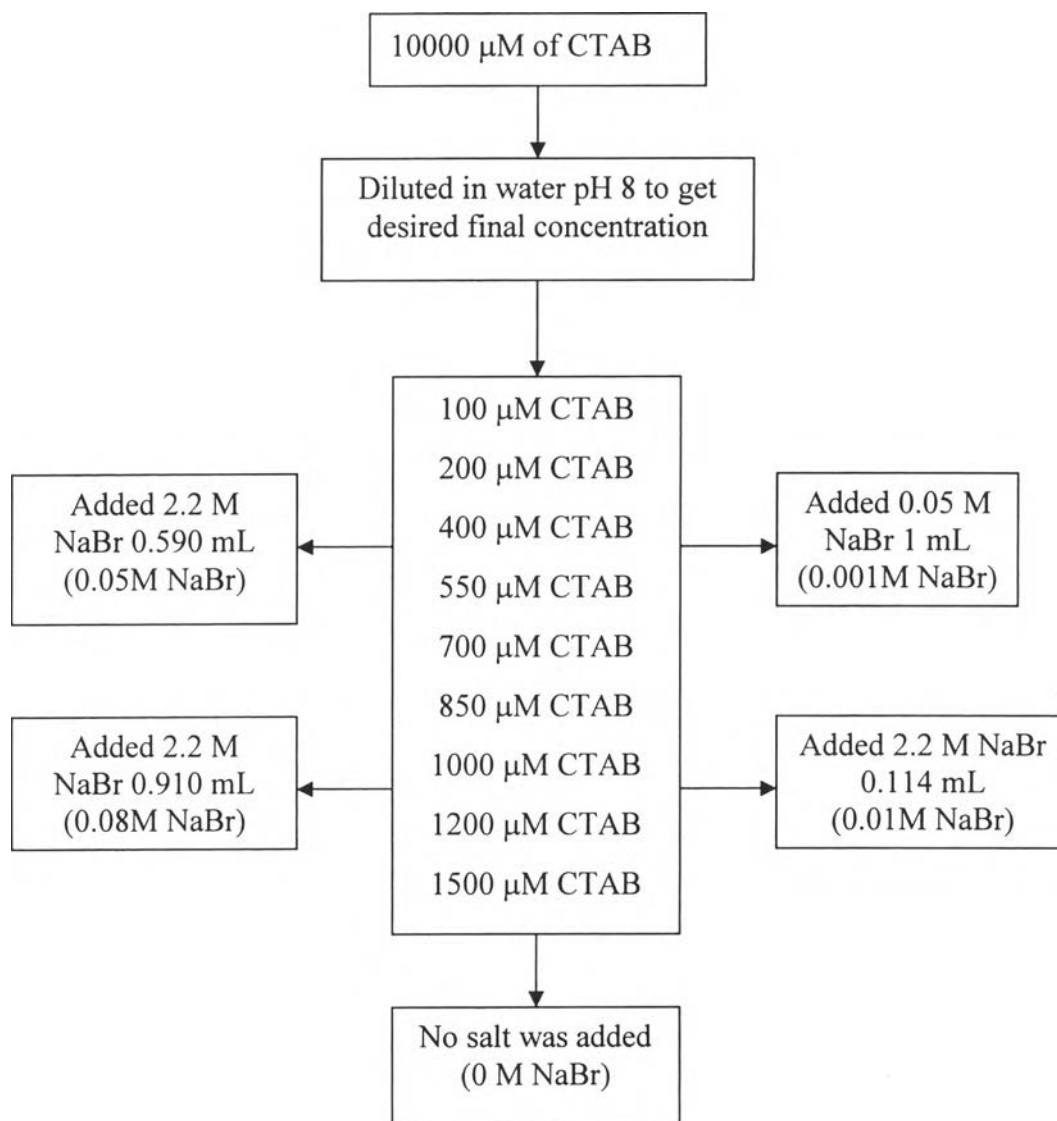
Table B1 The amount of 10000 μM CTAB solution used for preparation of 25 mL of CTAB solution at various concentrations.

CTAB concentration (μM)	Amount of 10,000 μM CTAB pipetted (mL)
100	0.25
250	0.625
400	1
550	1.375
700	1.75
850	2.125
1000	2.5
1200	3
1500	3.75
1800	4.5

Table B2 The amount of salt used for preparing CTAB solution at various concentrations of salt.

Concentration of salt (M)	Amount pipetted (mL)
0	0
0.001	0.05 M NaBr 1 mL
0.01	2.2 M NaBr 0.114 mL
0.05	2.2 M NaBr 0.590 mL
0.08	2.2 M NaBr 0.910 mL

Figure B1 The procedure for preparation of sample to study the effect of salt on the critical micelle concentration.



The series of surfactant at various CTAB concentrations were prepared. Each series had different concentrations of salt (NaBr). The surface tension of the samples was measured by DSA for studying the effect of salt on the critical micelle concentration

Results:

Table B3 The surface tension of CTAB solution at various concentrations with 0.08M NaBr.

0.08M NaBr	Surface tension(mN/m)					
conc.of CTAB	1	2	3	4	5	AV
100	35.35	35.7	35.21	35.75	35.18	35.44
250	32.3	32.39	32.36	32.25	32.2	32.3
400	32.18	32.2	32.22	32.24	32.23	32.21
550	32.02	32.02	32.02	32.97	32.91	32.39
700	32.18	32.13	32.09	32.14	32.22	32.15
850	32.1	32.11	32.15	32.16	32.28	32.16
1000	32.25	32.47	32.12	32.39	32.27	32.3
1200	31.93	31.93	31.83	31.83	31.84	31.87
1500	32.53	32.38	32.4	32.48	32.28	32.41

Table B4 The surface tension of CTAB solution at various concentrations with 0.05M NaBr.

0.05M NaBr	Surface tension(mN/m)					
conc.of CTAB	1	2	3	4	5	AV
100	34.62	34.35	34.2	33.92	33.86	34.19
250	31.91	32.08	32.23	32.44	32.2	32.17
400	31.97	32.14	32.31	32.18	32.29	32.18
550	32.07	31.79	31.86	32	31.71	31.89
700	32.07	32.09	31.98	31.95		32.02
850	31.95	31.79	31.62	31.81	31.78	31.79
1000	32.07	32.27	32.33	32.35	32.29	32.26
1200	32	32.17	32.28	32.27	32.26	32.19
1500	32.04	32.82	31.95	31.85	31.93	32.12

Table B5 The surface tension of CTAB solution at various concentrations with 0.01M NaBr.

0.01M NaBr	Surface tension(mN/m)					
conc.of CTAB	1	2	3	4	5	AV
100	42.91	42.65	42.1	42.79	42.99	42.69
250	34.58	34.85	34.8	34.49	34.66	34.68
400	34.01	34	33.94	34.17	34.12	34.05
550	34.1	34.13	34.23	34.26	33.94	34.13
700	34.46	34.45	34.35	34.18	34.19	34.33
850	33.81	33.85	34	34.14	33.71	33.90
1000	33.98	33.77	33.72	33.78	34	33.85

Table B6 The surface tension of CTAB solution at various concentrations with 0.001M NaBr.

0.001M NaBr	Surface tension(mN/m)					
conc.of CTAB	1	2	3	4	5	AV
100	56.84	56.66	56.62	56.66	56.46	56.65
250	46.57	46.42	46.47	46.95	46.44	46.57
400	41.91	41.97	42.08	42	42.59	42.11
550	38.33	38.33	38.46	38.32	38.2	38.33
700	36.09	36.2	36.21	36.53	36.61	36.33
850	36.23	36.21	36.27	36.17	36.5	36.28
1000	36.49	36.4	36.46	36.28	36.37	36.4
1200	36.06	36.5	36.4	36.55	36.46	36.39
1500	35.98	36.29	36.41	36.07	36.06	36.16
1800	36.23	36.35	36.16	36.04	36.28	36.21

Table B7 The surface tension of CTAB solution at various concentrations with 0M NaBr.

0 M NaBr	Surface tension(mN/m)			
Conc.of CTAB	1	2	3	AV.
0	70.44	70.84	70.38	70.55
100	62.58	63.71	62.34	62.88
250	56.69	56.81	56.09	56.53
400	49.83	49.83	49.69	49.78
550	45.64	45.42	45.18	45.41
700	41.81	41.31	42.88	42
850	39.41	39.41	39.45	39.42
1000	37.94	37.84	37.65	37.81
1200	37.25	37.55	37.41	37.40
1500	37.23	37.22	37.28	37.24
1800	37	37.04	37.32	37.12
2000	37.1	37.32	37.44	37.29

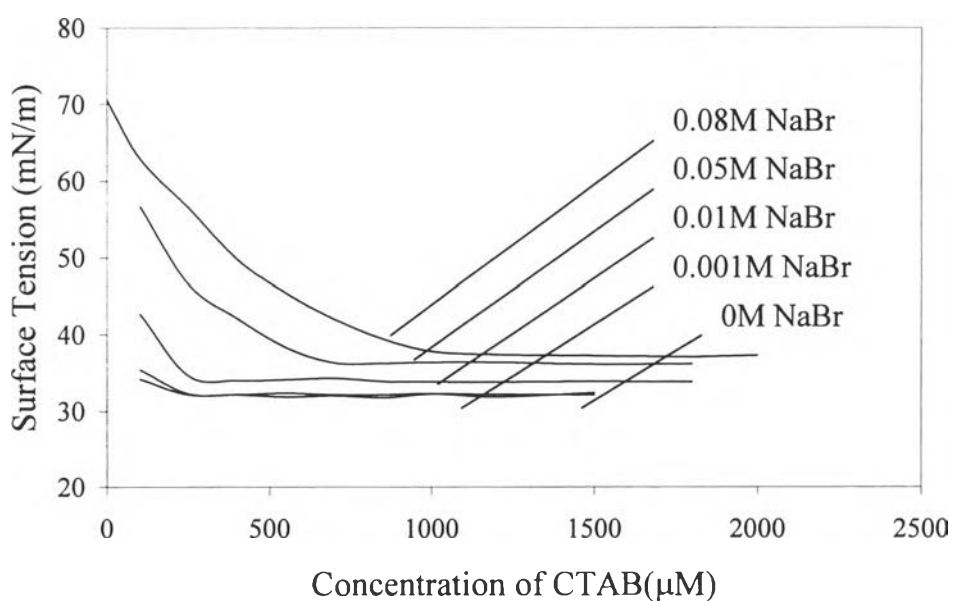


Figure B2 The effect of salt on CMC.

Appendix C The time for equilibrium adsorption.

Preparation:

1. 2,000 μM Surfactant (Cetyltrimethylammonium bromide:CTAB)

10,000 μM of CTAB 100 mL. was diluted with water pH 8 to get 2,000 μM of CTAB 500 mL. in the volumetric flask.

Calculation:

$$c_1 v_1 = c_2 v_2$$

$$2000(500) = 10000(x)$$

$$x = \frac{2000 \times 500}{10000}$$

$$x = 100 \text{ mL}$$

\therefore pipette 10,000 μM of CTAB 100 mL

2. % W/V of NR solution

60% W/V NR solution was dispersed in water pH 8 and centrifuged twice (8000 rpm, 20°C, break 2) then the creamy NR was weighed and diluted in water pH 8 to get 1% W/V of NR solution

Calculation:

$$\frac{1 \text{ g NR}}{100 \text{ mL}} = \frac{x \text{ g}}{50 \text{ mL}}$$

$$x = \frac{1 \text{ g NR} \times 50 \text{ mL}}{100 \text{ mL}}$$

$$x = 0.5 \text{ g}$$

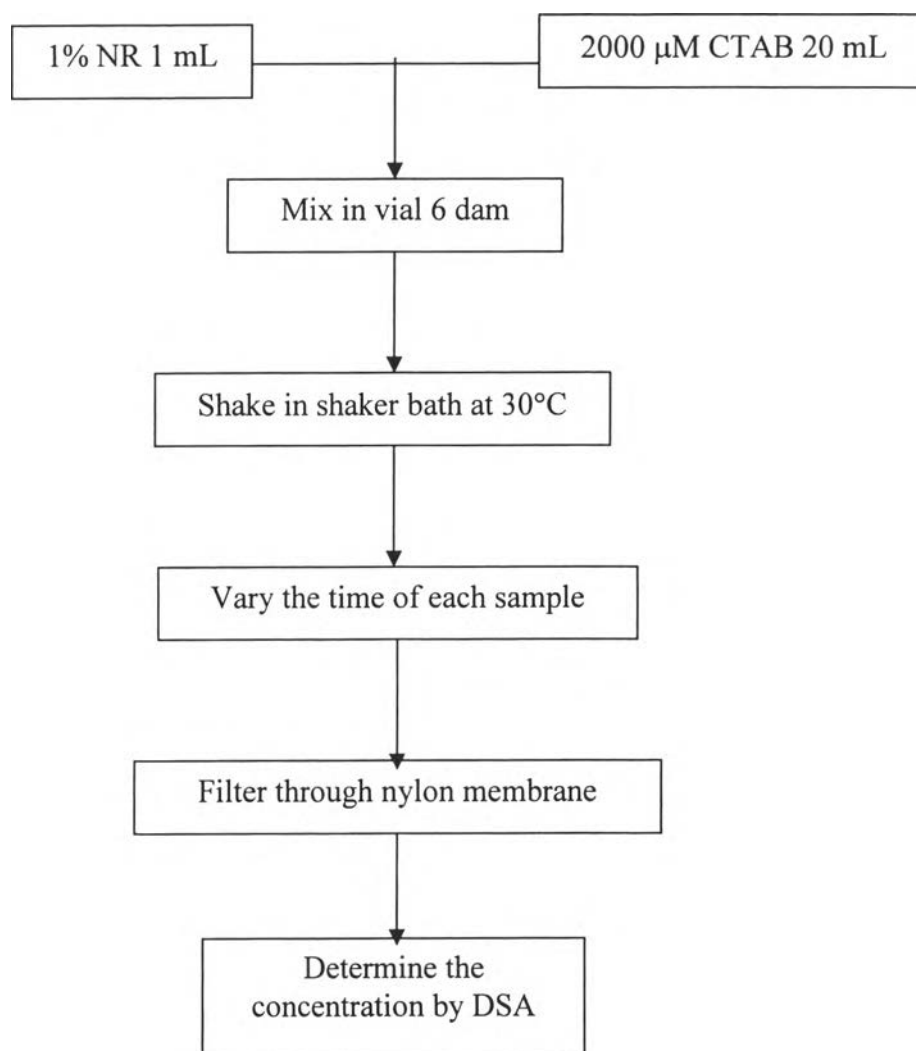
\therefore weigh 0.5g of NR cream

Procedure:

1. Pipette 1% W/V of NR solution 1 mL. into vials screw cap (size 6 dam).

2. Add 2,000 μM CTAB 20 mL.
3. Shake them in shaker bath at 30°C.
4. Vary the time of shaking for each sample.
5. Filter it through filter holder contained with nylon membrane.
6. Measure the values of surface tension by DSA

Figure C1 The procedure to find the time for equilibrium.



Results:

Table C1 The amount of adsorbed surfactant at different time.

No.	hrs.	Surface tension mN/m						conc.	eq.conc	AS.	AS
								uM		umol/sq.m	
1	2	52.8	54.8	55.7	53.2	55.3	54.4	296.2	1184.9	815.1	211.00
2	4	51.6	52.4	52.1	52.5	52.7	52.2	338.0	1352.1	647.9	167.72
3	6	52.6	52.2	52.5	52.3	52.6	52.4	334.2	1336.9	663.1	171.65
4	8	52.6	52.6	52.6	52.7	51.9	52.5	333.1	1332.4	667.6	172.83
5	10	51.3	51.8	52.8	52.0	51.8	51.9	343.9	1375.4	624.6	161.69
6	12	52.9	53.1	53.0	53.1	52.4	52.9	325.1	1300.3	699.7	181.14
7	14	54.0	55.2	55.2	55.2	55.6	55.0	283.3	1133.1	866.9	224.41
8	16	55.0	55.4	55.3	54.8	53.0	54.7	289.9	1159.6	840.4	217.56
9	18	55.8	55.4	55.4	54.7	53.2	54.9	286.6	1146.3	853.7	221.01
10	20	52.9	52.4	53.3	53.8	53.2	53.1	321.3	1285.1	714.9	185.07
11	22	52.1	53.3	53.5	53.6	53.5	53.2	319.0	1276.2	723.8	187.38
12	24	52.0	52.6	52.9	52.9	52.7	52.6	330.6	1322.4	677.6	175.42
13	26	52.0	51.9	52.0	51.5	52.0	51.9	345.3	1381.2	618.8	160.19
14	28	54.3	54.5	54.0	54.3	55.1	54.4	295.1	1180.4	819.6	212.17
16	32	54.7	54.9	54.7	54.5	54.8	54.7	289.5	1158.2	841.8	217.93
17	35	52.2	52.5	52.7	52.8	52.7	52.6	330.9	1323.6	676.4	175.10
18	97	50.2	51.3	51.9	51.8	51.7	51.4	354.6	1418.3	581.7	150.58
19	99	54.2	54.8	54.8	54.5	54.9	54.6	291.6	1166.5	833.5	215.78

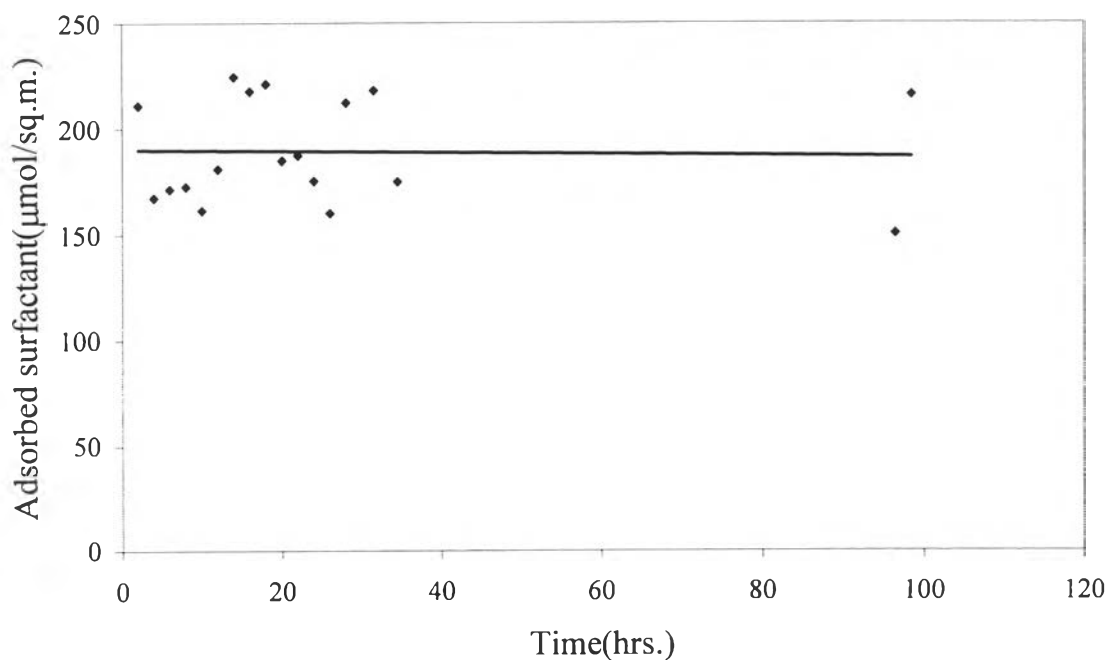


Figure C2 Adsorbed surfactant at various time.

Appendix D Calibration curve

From Appendix B, the linear region was used as the calibration for the adsorption isotherm curve in Appendix E.

Table D1 The data for calibration curve of 0 M NaBr.

Std.CTAB (uM)	Surface tension(mN/m)			
	1	2	3	AV.
0 M NaBr				
0	70.44	70.84	70.38	70.55
100	62.58	63.71	62.34	62.88
250	56.69	56.81	56.09	56.53
400	49.83	49.83	49.69	49.78
550	45.64	45.42	45.18	45.41
700	41.81	41.31	42.88	42
850	39.41	39.41	39.45	39.42
1000	37.94	37.84	37.65	37.81
1200	37.25	37.55	37.41	37.40
1500	37.23	37.22	37.28	37.24
1800	37	37.04	37.32	37.12
2000	37.1	37.32	37.44	37.29

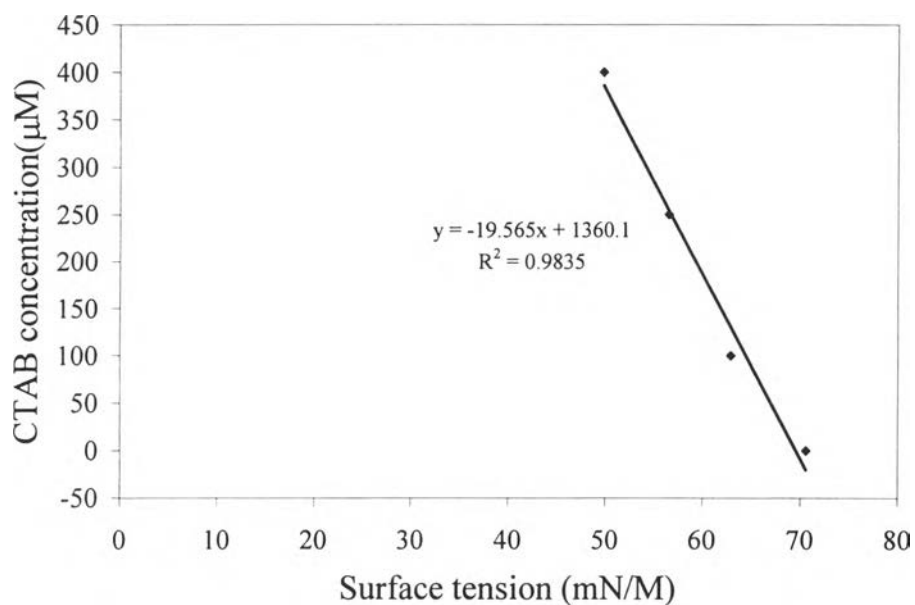


Figure D1 Calibration curve 0-400 μM CTAB (0 M NaBr).

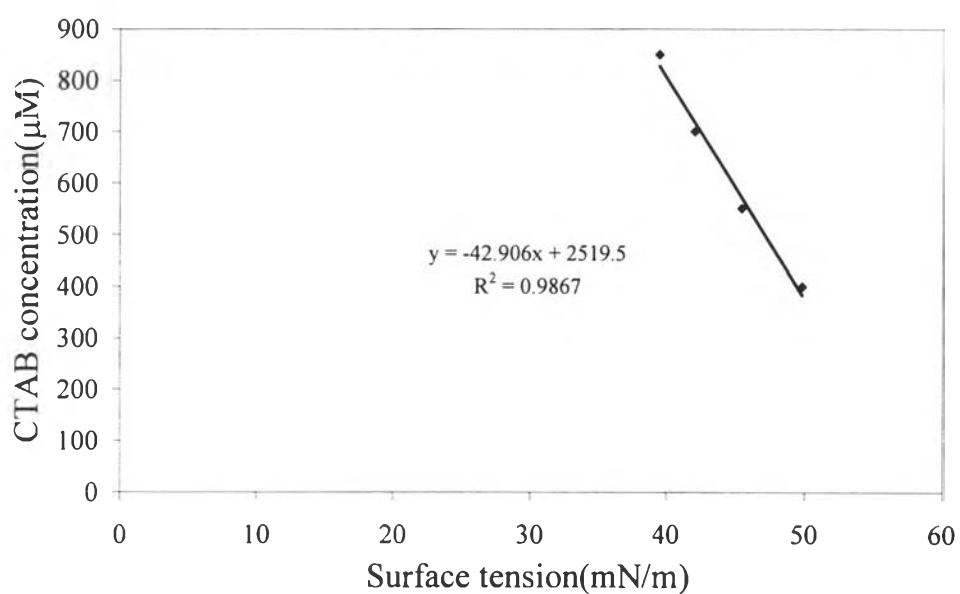


Figure D2 Calibration curve 400-800 μM CTAB (0 M NaBr).

Table D2 The data for calibration curve of 0.001 M NaBr.

Std.CTAB (μ M)	Surface tension(mN/m)					
	1	2	3	4	5	AV
0 M NaBr						
15.00	70.92	70.23	70.96	71.02	70.94	70.81
30.00	68.91	69.19	68.31	67.05	68.38	68.37
45.00	65.36	66.73	65.90	66.82	65.98	66.16
60.00	64.82	64.38	66.02	65.17	65.57	65.19
75.00	61.18	61.98	62.22	62.10	61.85	61.87
90.00	60.15	60.15	60.78	60.02	60.31	60.28
100.00	57.84	57.94	58.09	58.19	57.91	57.99
120.00	56.09	56.67	56.34	55.10	55.51	55.94
150.00	52.24	52.43	53.03	53.86	52.67	52.85
180.00	51.07	54.05	52.85	54.23	54.47	53.33
100.00	56.84	56.66	56.62	56.66	56.46	56.65
250.00	46.57	46.42	46.47	46.95	46.44	46.57
400.00	41.91	41.97	42.08	42.00	42.59	42.11
550.00	38.33	38.33	38.46	38.32	38.20	38.33
700.00	36.09	36.20	36.21	36.53	36.61	36.33
850.00	36.23	36.21	36.27	36.17	36.50	36.28
1000.00	36.49	36.40	36.46	36.28	36.37	36.40
1200.00	36.06	36.50	36.40	36.55	36.46	36.39
1500.00	35.98	36.29	36.41	36.07	36.06	36.16
1800.00	36.23	36.35	36.16	36.04	36.28	36.21

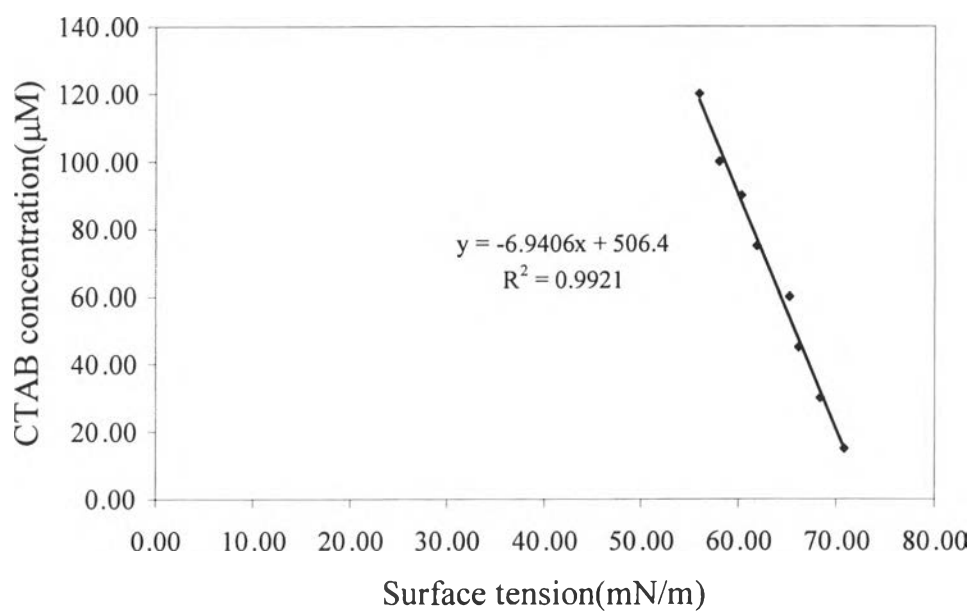


Figure D3 Calibration curve for 15-120μM CTAB(1 mM NaBr).

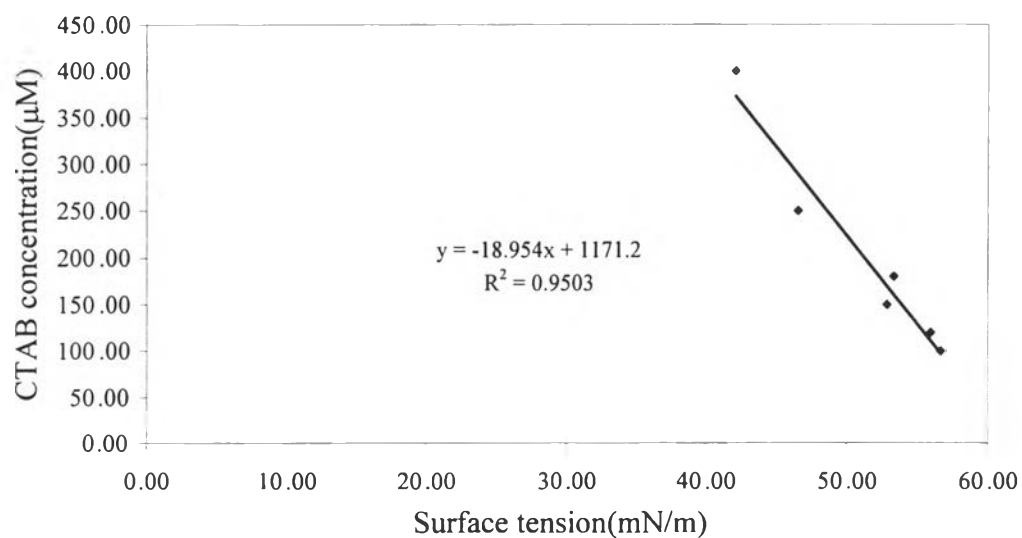


Figure D4 Calibration curve for 120-400μM CTAB (1 mM NaBr).

Appendix E Surfactant adsorption isotherm.

Preparation:

1. 1% W/V of NR solution

60% W/V NR solution was dispersed in water pH 8 and centrifuged twice then the creamy NR was weighed and diluted in water pH 8 to get 1% W/V of NR solution.

2. CTAB surfactant at various concentrations.

10,000 μ M of CTAB solution was pipette at various volumes and diluted with water pH 8 to get 100 mL of various CTAB in volumetric flask.

Procedure:

1. Pipette 1% W/V of NR solution 1 mL into vials screw cap (size 6 dam).
2. Add CTAB solution at various concentrations 20 mL into each bottle.
3. Shake them in shaker bath at 30°C.
4. After equilibrium filter it through filter holder contain with nylon membrane.
5. Measure the values of surface tension by DSA

Table E1 Adsorption isotherm with no salt

Initial conc. CTAB	final conc. CTAB	AV. surface tension(mN/m)	eq.conc.(uM)	AS.CTAB(uM)	AS.CTAB(umol)	AS.CTAB(umol/sq.m)
250.00	238.10	57.95	226.31	11.79	0.25	2.96
550.00	523.81	45.60	467.94	55.87	1.17	14.04
700.00	666.67	40.47	568.30	98.36	2.07	24.72
850.00	809.52	52.55	663.80	145.72	3.06	36.62
1000.00	952.38	50.08	760.57	191.81	4.03	48.20
1200.00	1142.86	46.80	888.80	254.06	5.34	63.84
1500.00	1428.57	51.82	1153.94	274.63	5.77	69.01
1800.00	1714.29	47.52	1434.57	279.72	5.87	70.29

Table E2 Adsorption isotherm with 1 mM NaBr

Initial conc. CTAB	final conc. CTAB	AV. surface tension(mN/m)	eq.conc.(uM)	AS.CTAB(uM)	AS.CTAB(umol)	AS.CTAB(umol/sq.m)
300.00	285.71	47.40	272.82	12.90	0.27	3.20
400.00	380.95	43.41	348.50	32.45	0.68	8.04
500.00	476.19	40.58	402.08	74.11	1.56	18.37
600.00	571.43	50.06	444.92	126.51	2.66	31.36
800.00	761.90	47.33	548.21	213.69	4.49	52.97
900.00	857.14	45.33	624.14	233.00	4.89	57.75
1000.00	952.38	43.53	692.15	260.23	5.46	64.50
1200.00	1142.86	67.94	870.70	272.16	5.72	67.46
1400.00	1333.33	66.90	1051.85	281.49	5.91	69.77

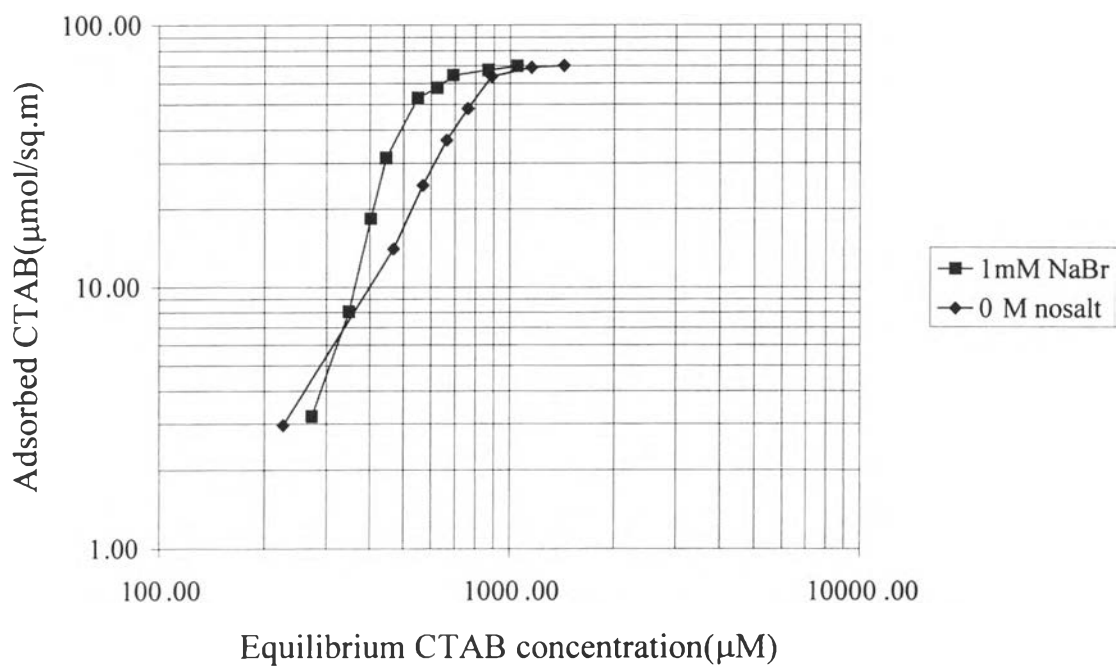


Figure E1 Adsorption isotherm of CTAB on NR.

Appendix F Monomer adsolubilization.

Preparation:

1. 1% W/V of NR solution

60% W/V NR solution was dispersed in water pH 8 and centrifuged twice then the creamy NR was weighed and diluted in water pH 8 to get 1% W/V of NR solution.

2. 2100 μ M CTAB in water pH 8

250 mL of 2100 μ M CTAB was prepared by weight CTAB 0.1913 g and dissolved in water pH 8 in volumetric flask 250ml.

$$\frac{2100 \times 10^{-6} \text{ mol}}{1000 \text{ mL}} = \frac{x \text{ mol}}{250 \text{ mL}}$$

$$x = 5.25 \times 10^{-4} \text{ mol}$$

$$x = 5.25 \times 10^{-4} \times 364.45$$

$$x = 0.1913 \text{ g}$$

In the case of 0.001M NaBr

NaBr was weigh 0.0540 g

$$\frac{2.1 \times 10^{-3} \text{ mol}}{1000 \text{ mL}} = \frac{x \text{ mol}}{250 \text{ mL}}$$

$$x = 5.25 \times 10^{-4} \text{ mol}$$

$$x = 5.25 \times 10^{-4} \times 102.89$$

$$x = 0.0540 \text{ g}$$

Procedure:

1. Pipette 1% W/V of NR solution 1 ml into vials screw cap (size 6 dam).
2. Add 10 mL of 2100 μ M CTAB and 9 mL of water.
3. Shake them in shaker bath at 30°C for 15 hrs.
4. After equilibrium surfactant adsorption pipette pure styrene monomer into vials to get various concentrations of styrene.
5. Shake the sample in shaker bath again at 30°C for 2 hrs.

6. After monomer adsolubilization filter it through filter holder containing nylon membrane.
7. Determine the concentration of styrene by UV.

Results:

Table F1 Data for calibration curve with no salt.

Conc.std	Absorbance
0	0
40	0.1154
80	0.4418
160	0.8769
320	1.3718

Table F2 Data for calibration curve with 1mM NaBr.

Conc.std	Absorbance
0	0
50	0.241
100	0.488
150	1.085

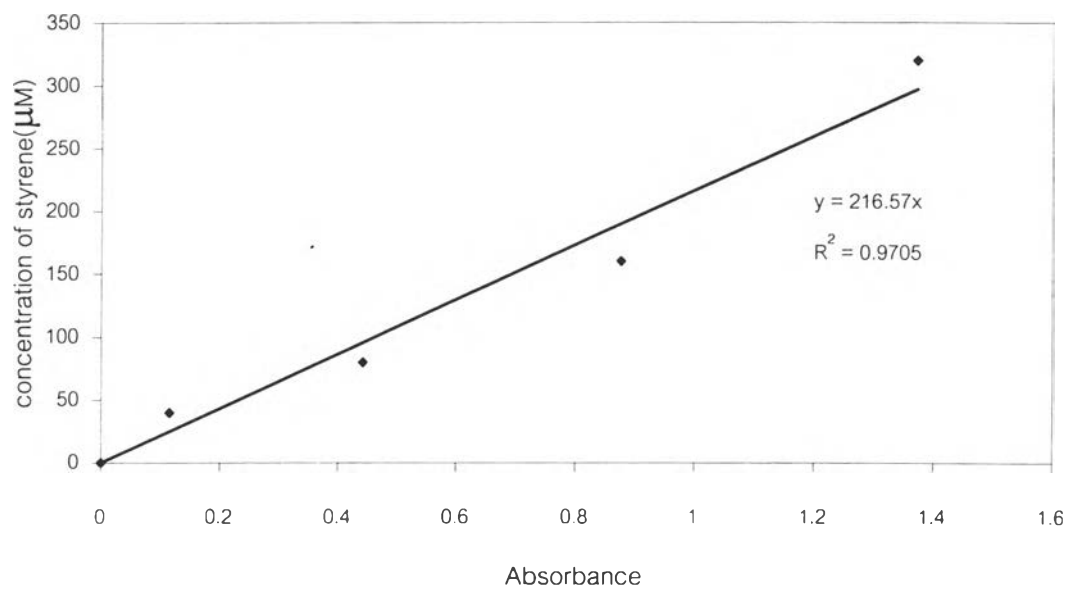


Figure F1 Calibration curve of styrene monomer.

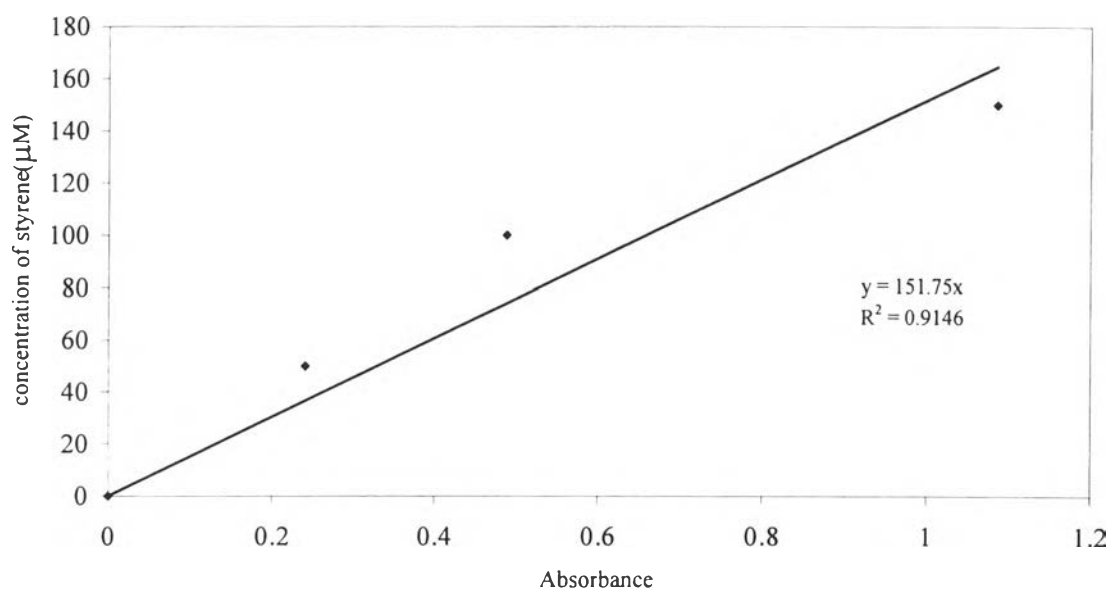


Figure F2 Calibration curve of styrene monomer (1mM NaBr).

Table F3 Monomer adsolubilization with no salt.

Conc. ini.	A UV	conc.from UV	eq.sty	as sty	umol/g	umol/sq.m
381	0.2292	40.60	243.60	137.35	288.45	35.56
1143	0.0845	14.96	348.92	793.93	1667.26	205.53
1333	0.1274	22.57	473.91	859.42	1804.79	222.48
1524	0.1517	26.86	564.12	959.69	2015.36	248.44
1714	0.1667	29.53	620.10	1094.19	2297.79	283.25
2476	0.2317	41.03	861.71	1614.49	3390.42	417.95
4762	0.4320	179.28	1972.10	2789.80	5858.59	722.20
9524	0.4540	188.58	2074.37	7449.44	15643.83	1928.46
14286	0.5450	227.29	2500.22	11785.49	24749.53	3050.94
19048	0.7400	309.97	3409.67	15637.95	32839.69	4048.24

Table F4 Monomer adsolubilization with 1 mM NaBr.

Conc. ini.	A UV	conc.from UV	eq.sty	as sty	umol/g	umol/sq.m
500	1.3900	284.67	284.67	215.33	452.19	72.89
1000	0.3170	65.21	370.01	629.99	1322.97	213.26
3000	0.7540	154.56	463.67	2536.34	5326.30	858.57
5000	0.2290	47.13	754.06	4245.94	8916.47	1437.28
8000	0.4310	88.57	1417.06	6582.94	13824.18	2228.38
10000	0.5040	103.57	1657.07	8342.93	17520.15	2824.15
20000	0.7070	145.08	2321.31	17678.69	37125.24	5984.37

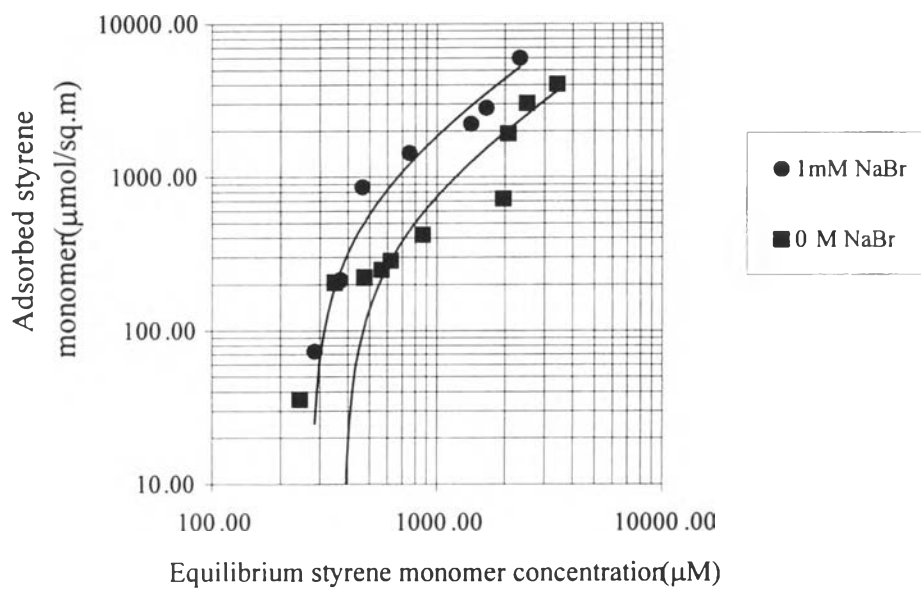


Figure F3 Adsorbed isotherm of styrene monomer into CTAB aggregates.

Appendix G Polymerization of polystyrene onto latex particle

Preparation:

1. 20% W/V of NR solution

60% W/V NR solution was dispersed in water pH 8 and centrifuged twice then the creamy NR was weighed and diluted in water pH 8 to get 20% W/V of NR solution.

2. 2100 μ M CTAB in water pH 8

250 ml of 2100 μ M CTAB was prepared by weight CTAB 0.1913 g and dissolved in water pH 8 in volumetric flask 250mL.

$$\frac{2100 \times 10^{-6} \text{ mol}}{1000 \text{ mL}} = \frac{x \text{ mol}}{250 \text{ mL}}$$

$$x = 5.25 \times 10^{-4} \text{ mol}$$

$$x = 5.25 \times 10^{-4} \times 364.45$$

$$x = 0.1913 \text{ g}$$

In the case of 0.001M NaBr

NaBr was weigh 0.0540 g

$$\frac{2.1 \times 10^{-3} \text{ mol}}{1000 \text{ mL}} = \frac{x \text{ mol}}{250 \text{ mL}}$$

$$x = 5.25 \times 10^{-4} \text{ mol}$$

$$x = 5.25 \times 10^{-4} \times 102.89$$

$$x = 0.0540 \text{ g}$$

Procedure:

1. Pipette 20% W/V of NR solution 5 mL(1g DRC) into screw cap vial (size 6 dam).
2. Add 10 mL of 2,100 μ M CTAB and 5 ml of water.
3. Shake them in shaker bath at 30°C for 15 hrs.
4. After equilibrium surfactant adsorption pipette pure styrene monomer into vials as in Table A7.1.
5. Shake the sample in shaker bath again at 30°C for 2 hrs
6. After monomer adsolubilization add V50 to start polymerization reaction as in Table A7.1

7. Shake the sample in shaker bath again at 70°C for 2 hrs for polymerization of styrene monomer on NR particles.
8. Stop the reaction by immersing the sample in an ice bath for 10 minute.
9. Wash NR with water to remove the upper layer of surfactant by filtering though dialysis tube (cellulose nitrate).
10. Separate NR from the mixture by centrifuging at 3000 rpm.
11. Dry the NR particles in the vacuum oven at 70°C for 16 hours.

Table G1 Sample preparation for admicellar polymerization.

Monomer(mM)	Pipette(μ l)	V50(ml)	V50(mM)
10	4.2	0.2	5
20	48.2	0.4	10
30	72.4	0.6	15
40	96.6	0.8	20
50	120	1	25
100	240	2	50

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