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APPENDIXES

Appendix A

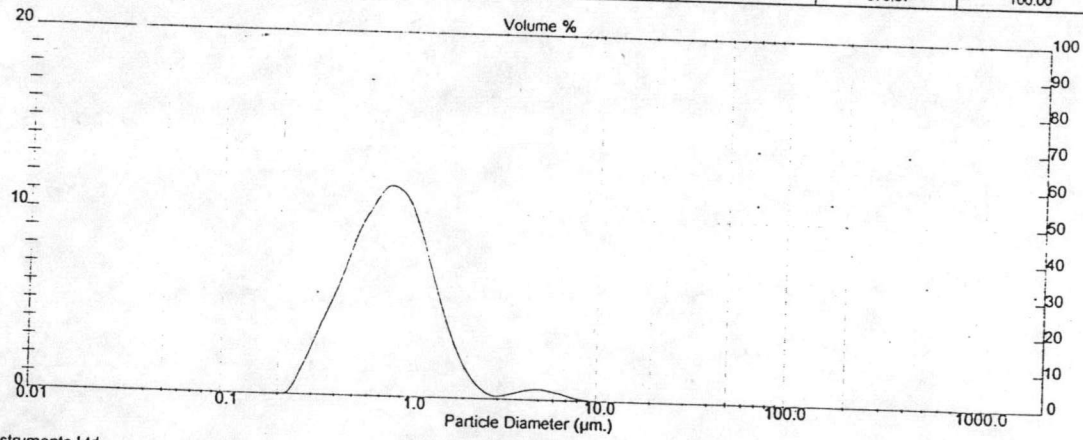
Result: Analysis Report

Sample Details		
Sample ID: WATER RUBBER	Run Number: 1	Measurement Date: Mon, Apr 26, 1999 2:19PM
Sample File: PORNCHAI	Record Number: 19	Analysis Date: Mon, Apr 26, 1999 2:19PM
Sample Path: A1		Result Source: Analysed
Sample Notes: Test by Pranee : Scientific and Technological Research Equipment Centre Chulalongkorn University. Liquid medium : WATER		

System Details		
Range Lens: 300RF mm	Beam Length: 2.40 mm	Sampler: MS17
Presentation: 30HD	[Particle R.I. = (* 5295, 0.1000)]:	Obscuration: 22.7 %
Analysis Model: Polydisperse	Dispersant R.I. = 1.3300	Residual: 0.350 %
Modifications: Active -	Killed Data Channels: Low 0, High 2	

Result Statistics		
Distribution Type: Volume	Concentration = 0.0039 %Vol	Density = 1.000 g / cub. cm
Mean Diameters	D (v, 0.1) = 0.40 um	D (v, 0.5) = 0.78 um
D [4, 3] = 0.97 um	D [3, 2] = 0.69 um	Span = 1.449E+00
		Specific S.A. = 8.6930 sq. m / g
		Uniformity = 5.544E-01

Size_Low (um)	In %	Size_High (um)	Under%	Size_Low (um)	In %	Size_High (um)	Under%
0.06	0.00	0.06	0.00	6.63	0.26	7.72	99.88
0.07	0.00	0.07	0.00	7.72	0.11	9.00	99.99
0.08	0.00	0.08	0.00	9.00	0.01	10.48	100.00
0.09	0.00	0.09	0.00	10.48	0.00	12.21	100.00
0.11	0.00	0.11	0.00	12.21	0.00	14.22	100.00
0.13	0.00	0.13	0.00	14.22	0.00	16.57	100.00
0.15	0.00	0.15	0.00	16.57	0.00	19.31	100.00
0.17	0.00	0.17	0.00	19.31	0.00	22.49	100.00
0.20	0.00	0.20	0.00	22.49	0.00	26.20	100.00
0.23	0.87	0.23	0.00	26.20	0.00	30.53	100.00
0.27	2.30	0.27	0.87	30.53	0.00	35.56	100.00
0.31	3.90	0.31	3.18	35.56	0.00	41.43	100.00
0.36	5.42	0.36	7.07	41.43	0.00	48.27	100.00
0.42	7.17	0.42	12.50	48.27	0.00	56.23	100.00
0.49	9.09	0.49	19.67	56.23	0.00	65.51	100.00
0.58	10.34	0.58	28.76	65.51	0.00	76.32	100.00
0.67	11.39	0.67	39.10	76.32	0.00	88.91	100.00
0.78	11.42	0.78	50.48	88.91	0.00	103.58	100.00
0.91	10.66	0.91	61.90	103.58	0.00	120.67	100.00
1.06	8.91	1.06	72.56	120.67	0.00	140.58	100.00
1.24	6.55	1.24	81.48	140.58	0.00	163.77	100.00
1.44	4.46	1.44	88.13	163.77	0.00	190.80	100.00
1.68	2.66	1.68	92.60	190.80	0.00	222.28	100.00
1.95	1.34	1.95	95.26	222.28	0.00	258.95	100.00
2.28	0.54	2.28	96.60	258.95	0.00	301.68	100.00
2.65	0.19	2.65	97.14	301.68	0.00	351.46	100.00
3.09	0.26	3.09	97.34	351.46	0.00	409.45	100.00
3.60	0.43	3.60	97.60	409.45	0.00	477.01	100.00
4.19	0.57	4.19	98.03	477.01	0.00	555.71	100.00
4.88	0.57	4.88	98.60	555.71	0.00	647.41	100.00
5.69	0.45	5.69	99.17	647.41	0.00	754.23	100.00
		6.63	99.52	754.23	0.00	878.67	100.00



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Malvern, UK
Tel:0684 892456 Fax:0684 892789

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Figure A.1 Chart diagram showing the size distribution of rubber particles

Specific S.A. = 8.6930 sq.m/g

Diameter = 0.78 µm

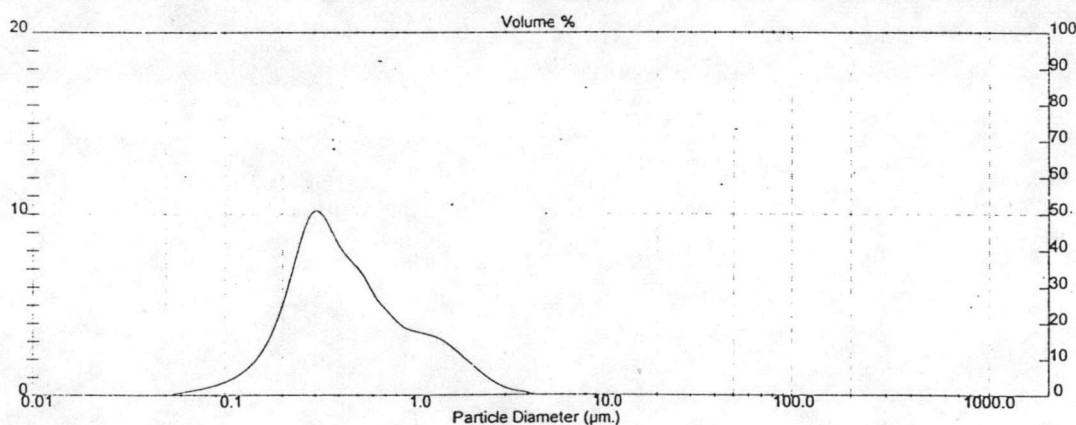
Result: Analysis Report

Sample Details		
Sample ID: ZnO	Run Number: 1	Measurement Date: Mon, Apr 26, 1999 1:31PM
Sample File: PORNCHAI	Record Number: 1	Analysis Date: Mon, Apr 26, 1999 1:32PM
Sample Path: A:\		Result Source: Analysed
Sample Notes: Test by Pranee : Scientific and Technological Research Equipment Centre Chulalongkorn University. Liquid medium : WATER		

System Details			
Range: Lens: 300RF mm	Beam Length: 2.40 mm	Sampler: MS17	Obscuration: 15.6 %
Presentation: 30HD	[Particle R.I. = (1.5295, 0.1000):	Dispersant R.I. = 1.3300]	Residual: 1.046 %
Analysis Model: Polydisperse	Killed Data Channels: Low 0; High 2		
Modifications: Active --			

Result Statistics			
Distribution Type: Volume	Concentration = 0.0027 %Vol	Density = 1.000 g / cub. cm	Specific S.A. = 17.3361 sq. m / g
Mean Diameters:	D (v, 0.1) = 0.19 um	D (v, 0.5) = 0.40 um	D (v, 0.9) = 1.33 um
D [4, 3] = 0.60 um	D [3, 2] = 0.35 um	Span = 2.854E+00	Uniformity = 8.483E-01

Size_Low (um)	In %	Size_High (um)	Under%	Size_Low (um)	In %	Size_High (um)	Under%
0.05	0.09	0.06	0.09	6.83	0.00	7.72	100.00
0.06	0.20	0.07	0.30	7.72	0.00	9.00	100.00
0.07	0.33	0.08	0.63	9.00	0.00	10.48	100.00
0.08	0.50	0.09	1.13	10.48	0.00	12.21	100.00
0.09	0.73	0.11	1.86	12.21	0.00	14.22	100.00
0.11	1.06	0.13	2.92	14.22	0.00	16.57	100.00
0.13	1.59	0.15	4.51	16.57	0.00	19.31	100.00
0.15	2.44	0.17	6.95	19.31	0.00	22.49	100.00
0.17	3.84	0.20	10.79	22.49	0.00	26.20	100.00
0.20	5.95	0.23	16.73	26.20	0.00	30.53	100.00
0.23	8.45	0.27	25.19	30.53	0.00	35.56	100.00
0.27	10.06	0.31	35.25	35.56	0.00	41.43	100.00
0.31	9.74	0.36	44.99	41.43	0.00	48.27	100.00
0.36	8.43	0.42	53.41	48.27	0.00	56.23	100.00
0.42	7.46	0.49	60.87	56.23	0.00	65.51	100.00
0.49	6.65	0.58	67.52	65.51	0.00	76.32	100.00
0.58	5.42	0.67	72.54	76.32	0.00	88.91	100.00
0.67	4.61	0.78	77.54	88.91	0.00	103.58	100.00
0.78	3.90	0.91	81.44	103.58	0.00	120.67	100.00
0.91	3.58	1.06	85.02	120.67	0.00	140.58	100.00
1.06	3.42	1.24	88.44	140.58	0.00	163.77	100.00
1.24	3.22	1.44	91.66	163.77	0.00	190.80	100.00
1.44	2.77	1.68	94.43	190.30	0.00	222.28	100.00
1.68	2.14	1.95	96.57	222.28	0.00	258.95	100.00
1.95	1.51	2.28	98.07	258.95	0.00	301.68	100.00
2.28	0.93	2.65	99.00	301.68	0.00	351.46	100.00
2.65	0.52	3.09	99.53	351.46	0.00	409.45	100.00
3.09	0.28	3.60	99.81	409.45	0.00	477.01	100.00
3.60	0.19	4.19	100.00	477.01	0.00	555.71	100.00
4.19	0.00	4.88	100.00	555.71	0.00	647.41	100.00
4.88	0.00	5.69	100.00	647.41	0.00	754.23	100.00
5.69	0.00	6.63	100.00	754.23	0.00	878.67	100.00



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Malvern, UK
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Figure A.2 Chart diagram showing the size distribution of zinc oxide dispersion

Specific S.A. = 17.3361 sq.m/g

Diameter = 0.40 µm

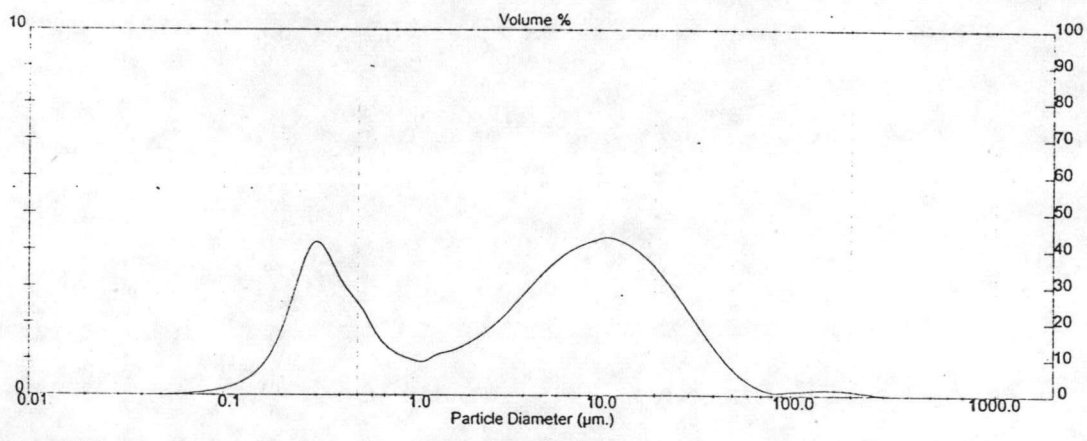
Result: Analysis Report

Sample Details		
Sample ID: TMTD	Run Number: 2	Measurement Date: Mon, Apr 26, 1999 1:47PM
Sample File: PORNCHAI	Record Number: 12	Analysis Date: Mon, Apr 26, 1999 1:47PM
Sample Path: A.1		Result Source: Analysed
Sample Notes: Test by Pranee : Scientific and Technological Research Equipment Centre Chulalongkorn University. Liquid medium : WATER		

System Details			
Range Lens: 300RF mm	Beam Length: 2.40 mm	Sampler: MS17	Obscuration: 21.0 %
Presentation: 3OHD	[Particle R.I. = (1.5295, 0.1000);	Dispersant R.I. = 1.3300]	Residual: 0.215 %
Analysis Model: Polydisperse	Killed Data Channels: Low 0; High 2		
Modifications: Active --			

Result Statistics			
Distribution Type: Volume	Concentration = 0.0081 %Vol	Density = 1.000 g / cub. cm	Specific S.A. = 6.6404 sq. m / g
Mcan Diameters:	D (v, 0.1) = 0.28 um	D (v, 0.5) = 5.25 um	D (v, 0.9) = 25.07 um
D [4, 3] = 10.61 um	D [3, 2] = 0.90 um	Span = 4.723E+00	Uniformity = 1.745E+00

Size_Low (um)	In %	Size_High (um)	Under%	Size_Low (um)	In %	Size_High (um)	Under%
0.05	0.02	0.06	0.02	6.53	3.97	7.72	59.54
0.06	0.04	0.07	0.05	7.72	4.14	9.00	63.67
0.07	0.07	0.08	0.12	9.00	4.25	10.48	67.93
0.08	0.11	0.09	0.24	10.48	4.33	12.21	72.26
0.09	0.18	0.11	0.42	12.21	4.24	14.22	76.50
0.11	0.28	0.13	0.70	14.22	4.07	16.57	80.57
0.13	0.46	0.15	1.16	16.57	3.81	19.31	84.33
0.15	0.77	0.17	1.93	19.31	3.44	22.49	87.82
0.17	1.32	0.20	3.25	22.49	3.00	26.20	90.82
0.20	2.23	0.23	5.48	26.20	2.50	30.53	93.32
0.23	3.29	0.27	8.86	30.53	1.97	35.56	95.29
0.27	4.15	0.31	13.01	35.56	1.46	41.43	96.76
0.31	3.96	0.36	16.98	41.43	1.01	48.27	97.76
0.36	3.29	0.42	20.26	48.27	0.63	56.23	98.39
0.42	2.78	0.49	23.05	56.23	0.35	65.51	98.74
0.49	2.44	0.58	25.39	65.51	0.18	76.32	98.92
0.58	1.74	0.67	27.13	76.32	0.09	88.91	99.01
0.67	1.32	0.78	28.46	88.91	0.12	103.58	99.13
0.78	1.11	0.91	29.56	103.58	0.13	120.67	99.26
0.91	0.98	1.06	30.54	120.67	0.16	140.58	99.41
1.06	0.93	1.24	31.47	140.58	0.17	163.77	99.58
1.24	1.11	1.44	32.58	163.77	0.16	190.80	99.74
1.44	1.20	1.68	33.78	190.80	0.13	222.28	99.86
1.68	1.33	1.95	35.11	222.28	0.08	258.95	99.95
1.95	1.52	2.28	36.63	258.95	0.04	301.68	99.99
2.28	1.73	2.65	38.36	301.68	0.01	351.46	100.00
2.65	2.01	3.09	40.37	351.46	0.00	409.45	100.00
3.09	2.32	3.60	42.69	409.45	0.00	477.01	100.00
3.60	2.68	4.19	45.38	477.01	0.00	555.71	100.00
4.19	3.05	4.88	48.42	555.71	0.00	647.41	100.00
4.88	3.41	5.69	51.84	647.41	0.00	754.23	100.00
5.69	3.73	6.63	55.57	754.23	0.00	878.67	100.00



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Figure A.3 Chart diagram showing the size distribution of tetramethylthiuram disulfide dispersion

Specific S.A. = 6.6404 sq.m/g

Diameter = 5.25 µm

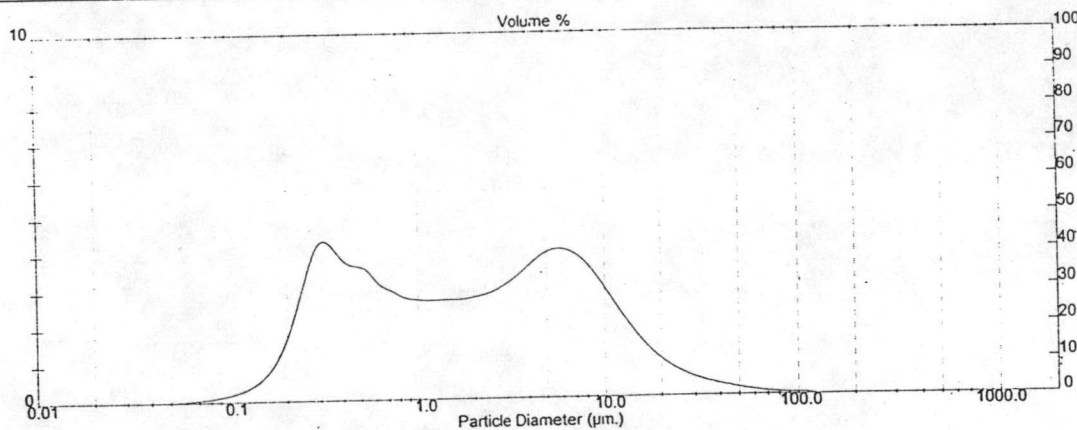
Result: Analysis Report

Sample Details		
Sample ID: ZBDC	Run Number: 2	Measurement Date: Mon, Apr 26, 1999 2:14PM
Sample File: PORNCHAI	Record Number: 16	Analysis Date: Mon, Apr 26, 1999 2:14PM
Sample Path: A:1		Result Source: Analysed
Sample Notes: Test by Pranee : Scientific and Technological Research Equipment Centre Chulalongkorn University. Liquid medium : WATER		

System Details		
Range Lens: 300RF mm	Beam Length: 2.40 mm	Sampler: MS17
Presentation: 30HD	[Particle R.I. = (1.5295, 0.1000)]; Dispersant R.I. = 1.3300]	Obscuration: 23.6 %
Analysis Model: Polydisperse		Residual: 0.203 %
Modifications: Active --	Killed Data Channels: Low 0; High 2	

Result Statistics			
Distribution Type: Volume	Concentration = 0.0067 %Vol	Density = 1.000 g / cub. cm	Specific S.A. = 7.8029 sq. m / g
Mean Diameters:	D (v, 0.1) = 0.28 um	D (v, 0.5) = 1.89 um	D (v, 0.9) = 11.48 um
D [4, 3] = 4.75 um	D [3, 2] = 0.77 um	Span = 5.919E+00	Uniformity = 2.161E+00

Size_Low (um)	In %	Size_High (um)	Under%	Size_Low (um)	In %	Size_High (um)	Under%
0.05	0.02	0.06	0.02	6.63	3.85	7.72	81.81
0.06	0.05	0.07	0.07	7.72	3.52	9.00	85.33
0.07	0.08	0.08	0.15	9.00	3.07	10.48	88.41
0.08	0.12	0.09	0.27	10.48	2.58	12.21	90.98
0.09	0.18	0.11	0.45	12.21	2.08	14.22	93.07
0.11	0.28	0.13	0.73	14.22	1.64	16.57	94.71
0.13	0.44	0.15	1.17	16.57	1.27	19.31	95.98
0.15	0.73	0.17	1.91	19.31	0.97	22.49	96.95
0.17	1.25	0.20	3.16	22.49	0.75	26.20	97.70
0.20	2.13	0.23	5.29	26.20	0.58	30.53	98.27
0.23	3.30	0.27	8.58	30.53	0.45	35.56	98.73
0.27	4.26	0.31	12.73	35.56	0.35	41.43	99.08
0.31	4.26	0.36	17.04	41.43	0.27	48.27	99.36
0.36	3.85	0.42	20.89	48.27	0.20	56.23	99.56
0.42	3.65	0.49	24.54	56.23	0.15	65.51	99.71
0.49	3.55	0.58	28.09	65.51	0.10	76.32	99.81
0.58	3.16	0.67	31.25	76.32	0.08	88.91	99.89
0.67	2.97	0.78	34.23	88.91	0.06	103.58	99.95
0.78	2.79	0.91	37.02	103.58	0.05	120.57	100.00
0.91	2.72	1.06	39.74	120.57	0.00	140.58	100.00
1.06	2.70	1.24	42.44	140.58	0.00	163.77	100.00
1.24	2.71	1.44	45.14	163.77	0.00	190.80	100.00
1.44	2.71	1.68	47.85	190.80	0.00	222.28	100.00
1.68	2.73	1.95	50.58	222.28	0.00	258.95	100.00
1.95	2.80	2.28	53.38	258.95	0.00	301.68	100.00
2.28	2.89	2.65	56.26	301.68	0.00	351.46	100.00
2.65	3.05	3.09	59.32	351.46	0.00	409.45	100.00
3.09	3.27	3.60	62.59	409.45	0.00	477.01	100.00
3.60	3.53	4.19	66.12	477.01	0.00	555.71	100.00
4.19	3.82	4.88	69.93	555.71	0.00	647.41	100.00
4.88	4.00	5.69	73.94	647.41	0.00	754.23	100.00
5.69	4.02	6.63	77.96	754.23	0.00	878.67	100.00



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Figure A.4 Chart diagram showing the size distribution of zinc dibutyl dithiocarbamate dispersion

Specific S.A. = 7.8029 sq.m/g

Diameter = 1.89 µm

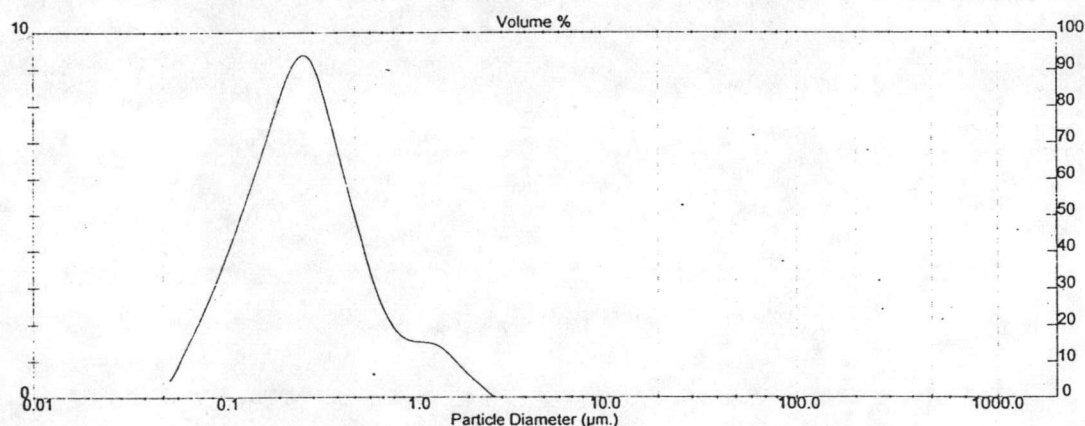
Result: Analysis Report

Sample Details		
Sample ID: TiO2	Run Number: 5	Measurement Date: Mon, Apr 26, 1999 1:42PM
Sample File: PORNCHAI	Record Number: 8	Analysis Date: Mon, Apr 26, 1999 1:42PM
Sample Path: A:\		Result Source: Analysed
Sample Notes: Test by Pranee : Scientific and Technological Research Equipment Centre Chulalongkorn University. Liquid medium : WATER		

System Details			
Range Lens: 3CORF mm	Beam Length: 2.40 mm	Sampler: MS17	Obscuration: 15.8 %
Presentation: 3OHD	[Particle R.I. = (1.5295, 0.1000);	Dispersant R.I. = 1.3300]	Residual: 1.611 %
Analysis Model: Polydisperse	Killed Data Channels: Low 0; High 2		
Modifications: Active --			

Result Statistics			
Distribution Type: Volume	Concentration = 0.0029 %Vol	Density = 1.000 g / cub. cm	Specific S.A. = 27.7667 sq. m / g
Mean Diameters:	D (v, 0.1) = 0.11 um	D (v, 0.5) = 0.26 um	D (v, 0.9) = 0.73 um
D [4, 3] = 0.37 um	D [3, 2] = 0.22 um	Span = 2.351E+00	Uniformity = 7.725E-01

Size_Low (um)	In %	Size_High (um)	Under%	Size_Low (um)	In %	Size_High (um)	Under%
0.05	0.48	0.05	0.48	5.63	0.00	7.72	100.00
0.06	1.10	0.07	1.58	7.72	0.00	9.00	100.00
0.07	1.81	0.08	3.39	9.00	0.00	10.48	100.00
0.08	2.59	0.09	5.98	10.48	0.00	12.21	100.00
0.09	3.42	0.11	9.40	12.21	0.00	14.22	100.00
0.11	4.33	0.13	13.73	14.22	0.00	16.57	100.00
0.13	5.31	0.15	19.05	16.57	0.00	19.31	100.00
0.15	6.39	0.17	25.43	19.31	0.00	22.49	100.00
0.17	7.52	0.20	32.95	22.49	0.00	26.20	100.00
0.20	8.58	0.23	41.53	26.20	0.00	30.53	100.00
0.23	9.27	0.27	50.80	30.53	0.00	35.56	100.00
0.27	9.22	0.31	60.02	35.56	0.00	41.43	100.00
0.31	8.33	0.36	68.35	41.43	0.00	48.27	100.00
0.36	7.00	0.42	75.35	48.27	0.00	56.23	100.00
0.42	5.67	0.49	81.02	56.23	0.00	65.51	100.00
0.49	4.39	0.58	85.40	65.51	0.00	76.32	100.00
0.58	3.18	0.67	88.59	76.32	0.00	88.91	100.00
0.67	2.31	0.78	90.90	88.91	0.00	103.58	100.00
0.78	1.77	0.91	92.67	103.58	0.00	120.67	100.00
0.91	1.56	1.05	94.23	120.67	0.00	140.58	100.00
1.06	1.52	1.24	95.75	140.58	0.00	163.77	100.00
1.24	1.46	1.44	97.20	163.77	0.00	190.80	100.00
1.44	1.22	1.66	98.42	190.80	0.00	222.28	100.00
1.68	0.85	1.95	99.28	222.28	0.00	258.95	100.00
1.95	0.51	2.28	99.79	258.95	0.00	301.68	100.00
2.28	0.21	2.65	100.00	301.68	0.00	351.46	100.00
2.65	0.00	3.09	100.00	351.46	0.00	409.45	100.00
3.09	0.00	3.60	100.00	409.45	0.00	477.01	100.00
3.60	0.00	4.19	100.00	477.01	0.00	555.71	100.00
4.19	0.00	4.88	100.00	555.71	0.00	647.41	100.00
4.88	0.00	5.69	100.00	647.41	0.00	754.23	100.00
5.69	0.00	6.63	100.00	754.23	0.00	878.67	100.00



Malvern Instruments Ltd.
Malvern, UK
Tel:0684 892456 Fax:0684 892789

Mastersizer S long bed Ver. 2.11
Serial Number: 32734-89

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Figure A.5 Chart diagram showing the size distribution of titanium dioxide dispersion

Specific S.A. = 27.7667 sq.m/g

Diameter = 0.26 µm

Appendix B

1. Mechanical Stability Time of Prevulcanized Latex

Table B.1 Mechanical stability time (MST) of prevulcanized latex at various amounts of potassium hydroxide

Amount of potassium hydroxide (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.25	1	82	1	95	
	2	83	2	98	
	3	86	3	113	
	mean	84	mean	102	93
0.50	1	79	1	80	
	2	82	2	83	
	3	88	3	83	
	mean	83	mean	82	83
0.75	1	90	1	103	
	2	90	2	106	
	3	96	3	112	
	mean	92	mean	107	100

Amount of potassium hydroxide (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
1.00	1	107	1	123	
	2	108	2	128	
	3	112	3	130	
	mean	109	mean	127	118

Table B.2 Mechanical stability time (MST) of prevulcanized latex at various amounts of tergitol NP9

Amount of Tergitol NP9 (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.25	1	90	1	93	
	2	93	2	98	
	3	93	3	100	
	mean	92	mean	97	95
0.50	The values are shown in Table B.1 at amount of potassium hydroxide 1 phr.				

Amount of NP9 (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.75	1	52	1	57	
	2	53	2	65	
	3	60	3	67	
	mean	55	mean	63	59
1.00	1	42	1	45	
	2	48	2	49	
	3	54	3	50	
	mean	48	mean	48	48

Table B.3 Mechanical stability time (MST) of prevulcanized latex at various amounts of casein

Amount of casein (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.25	1	95	1	95	
	2	96	2	104	
	3	103	3	107	
	mean	98	mean	102	100

Amount of casein (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.50	The values are shown in Table B.1 at amount of potassium hydroxide 1 phr.				
0.75	1	147	1	159	
	2	153	2	169	
	3	168	3	170	
	mean	156	mean	166	161

Table B.4 Mechanical stability time (MST) of prevulcanized latex at various amounts of ammonium laurate

Amount of ammonium laurate (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.05	1	528	1	533	
	2	531	2	540	
	3	543	3	553	
	mean	534	mean	542	538

Amount of ammonium laurate (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	MST (second)	specimen	MST (second)	
0.10	1	675	1	683	
	2	683	2	689	
	3	688	3	695	
	mean	682	mean	689	686
0.15	1	710	1	721	
	2	719	2	730	
	3	725	3	730	
	mean	718	mean	727	723

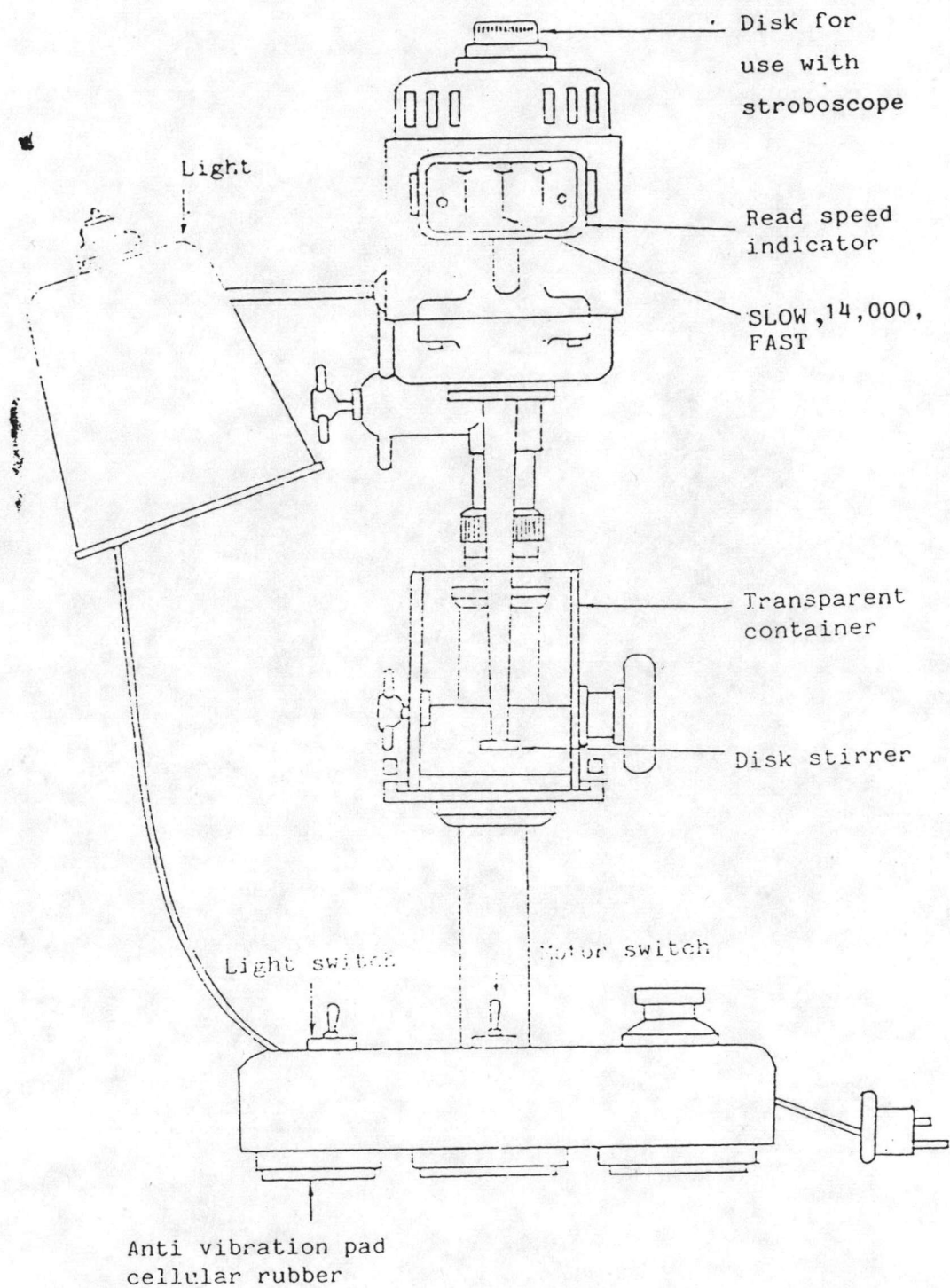


Figure B.1 Natural rubber latex mechanical stability apparatus (Front view)

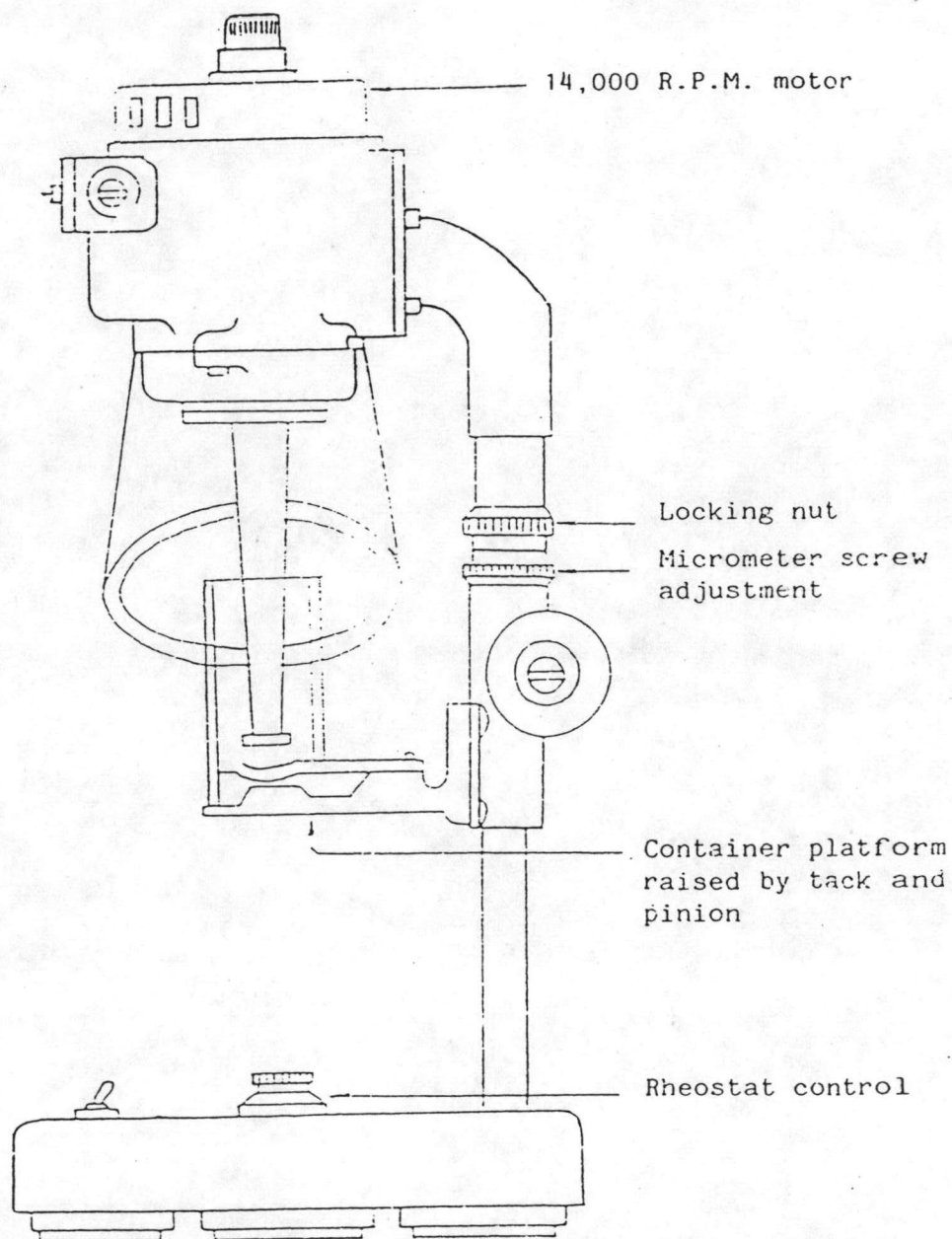


Figure B.2 Natural rubber latex mechanical stability apparatus (Side view)

Appendix C

1. Tensile Strength of Vulcanized Sheets

Table C.1 Tensile strength of vulcanized sheets that used ammonium laurate 0.15 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
1	1	9.01	1	8.41	
	2	8.93	2	8.45	
	3	8.09	3	9.16	
	4	8.87	4	8.95	
	mean	8.73	mean	8.74	8.74
2	1	13.70	1	13.69	
	2	13.45	2	13.95	
	3	13.94	3	18.52	
	4	12.11	4	19.56	
	mean	13.30	mean	16.43	14.87

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
3	1	18.09	1	22.42	
	2	20.56	2	22.80	
	3	21.90	3	20.11	
	4	20.09	4	21.11	
	mean	20.16	mean	21.61	20.89

Table C.2 Tensile strength of vulcanized sheets that used ammonium laurate 0.15 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
1.25	1	15.33	1	13.38	
	2	12.36	2	13.59	
	3	14.28	3	13.11	
	4	10.44	4	13.92	
	mean	13.10	mean	13.50	13.30

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
2.50 The values are shown in Table C.1 at TMTD 2 phr					
3.75	1	12.84	1	15.93	
	2	13.64	2	15.63	
	3	14.56	3	15.15	
	4	11.78	4	15.57	
	mean	13.21	mean	15.57	14.339

Table C.3 Tensile strength of vulcanized sheets that used Tergitol NP9 0.5 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
1	1	14.34	1	15.70	
	2	14.10	2	14.46	
	3	13.90	3	14.65	
	4	14.08	4	15.25	
	mean	14.11	mean	15.02	14.57

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
2	1	15.12	1	15.78	
	2	14.42	2	15.44	
	3	14.41	3	15.93	
	4	15.61	4	16.17	
	mean	14.89	mean	15.83	15.36
3	1	20.14	1	20.90	
	2	19.02	2	21.56	
	3	20.29	3	20.97	
	4	19.86	4	20.59	
	mean	19.83	mean	21.01	20.42

Table C.4 Tensile strength of vulcanized sheets that used Tergitol NP9 0.5 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Tensile strength (MPa)	specimen	Tensile strength (MPa)	
1.25	1	12.70	1	14.24	
	2	12.70	2	13.72	
	3	13.76	3	13.47	
	4	13.32	4	-	
	mean	13.12	mean	13.81	13.47
2.50 The values are shown in Table C.3 at TMTD 2 phr					
3.75	1	13.11	1	15.75	
	2	13.82	2	16.04	
	3	12.68	3	15.06	
	4	13.71	4	15.93	
	mean	13.33	mean	15.70	14.52

2. Elongation of Vulcanized Sheets

Table C.5 Elongation of vulcanized sheets that used ammonium laurate 0.15 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Elongation (%)	specimen	Elongation (%)	
1	1	840	1	840	
	2	920	2	872	
	3	904	3	932	
	4	836	4	940	
	mean	875	mean	896	886
2	1	808	1	800	
	2	780	2	800	
	3	776	3	792	
	4	792	4	820	
	mean	789	mean	803	796
3	1	740	1	760	
	2	748	2	736	
	3	736	3	756	
	4	756	4	756	
	mean	745	mean	752	749

Table C.6 Elongation of vulcanized sheets that used ammonium laurate 0.15 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Elongation (%)	specimen	Elongation (%)	
1.25	1	800	1	848	
	2	816	2	828	
	3	828	3	808	
	4	832	4	800	
	mean	819	mean	821	820
2.50 The values are shown in Table C.5 at TMTD 2 phr					
3.75	1	788	1	820	
	2	824	2	848	
	3	844	3	828	
	4	780	4	828	
	mean	809	mean	831	820

Table C.7 Elongation of vulcanized sheets that used Tergitol NP9 0.5 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Elongation (%)	specimen	Elongation (%)	
1	1	908	1	948	
	2	908	2	960	
	3	932	3	960	
	4	940	4	948	
	mean	922	mean	954	938
2	1	860	1	852	
	2	828	2	860	
	3	836	3	860	
	4	848	4	853	
	mean	843	mean	856	850
3	1	780	1	780	
	2	760	2	772	
	3	768	3	780	
	4	772	4	768	
	mean	770	mean	775	773

Table C.8 Elongation of vulcanized sheets that used Tergitol NP9 0.5 phr , TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Elongation (%)	specimen	Elongation (%)	
1.25	1	840	1	860	
	2	852	2	840	
	3	844	3	860	
	4	860	4	-	
	mean	849	mean	853	851
2.50 The values are shown in Table C.7 at TMTD 2 phr					
3.75	1	880	1	880	
	2	860	2	860	
	3	860	3	860	
	4	860	4	872	
	mean	865	mean	868	867

3. Hardness of Vulcanized Sheets

Table C.9 Hardness of vulcanized sheets that used ammonium laurate 0.15 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
1	1	25.2	1	24.3	
	2	26.7	2	27.6	
	3	27.4	3	27.8	
	4	28.5	4	29.0	
	5	28.7	5	29.4	
	mean	27.4	mean	27.8	27.6
2	1	28.7	1	28.9	
	2	29.0	2	29.5	
	3	29.2	3	29.6	
	4	29.8	4	30.2	
	5	30.1	5	30.2	
	mean	29.2	mean	29.6	29.4

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
3	1	30.0	1	30.5	
	2	30.6	2	30.8	
	3	30.8	3	31.1	
	4	31.3	4	31.8	
	5	32.2	5	32.0	
	mean	30.8	mean	31.1	31.0

Table C.10 Hardness of vulcanized sheets that used ammonium laurate 0.15 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
1.25	1	24.2	1	24.5	
	2	25.4	2	25.6	
	3	27.5	3	28.1	
	4	28.2	4	29.4	
	5	28.7	5	30.4	
	mean	27.5	mean	28.1	27.8
2.50	The values are shown in Table C.9 at TMTD 2 phr				

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
3.75	1	28.9	1	29.3	
	2	30.4	2	29.9	
	3	30.8	3	31.4	
	4	31.1	4	31.7	
	5	31.4	5	31.8	
	mean	30.8	mean	31.4	31.1

Table C.11 Hardness of vulcanized sheets that used Tergitol NP9 0.50 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
1	1	27.5	1	28.2	
	2	28.2	2	28.4	
	3	28.7	3	29.1	
	4	29.2	4	29.1	
	5	29.2	5	29.4	
	mean	28.7	mean	29.1	28.9

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
2	1	28.3	1	28.5	
	2	29.1	2	29.4	
	3	30.0	3	31.2	
	4	30.5	4	31.2	
	5	32.1	5	32.0	
	mean	30.0	mean	31.2	30.6
3	1	31.8	1	32.2	
	2	32.5	2	32.5	
	3	32.9	3	33.2	
	4	32.9	4	33.4	
	5	34.8	5	33.8	
	mean	32.9	mean	33.2	33.1

Table C.12 Hardness of vulcanized sheets that used Tergitol NP9 0.50 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	positions	Hardness (shore A)	positions	Hardness (shore A)	
1.25	1	24.9	1	25.6	
	2	26.4	2	26.7	
	3	26.8	3	27.0	
	4	27.2	4	31.8	
	5	27.7	5	32.4	
	mean	26.8	mean	27.0	26.9
2.50	The values are shown in Table C.11 at TMTD 2 phr				
3.75	1	32.2	1	33.9	
	2	32.8	2	35.0	
	3	33.5	3	35.4	
	4	34.4	4	36.8	
	5	35.6	5	37.3	
	mean	33.5	mean	35.4	34.5

3. Adhesion Strength of Solder Masks

Table C.13 Adhesion strength of solder masks that used ammonium laurate 0.15 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Adhesion strength (N)	specimen	Adhesion strength (N)	
1	1	103.30	1	111.60	110.30
	2	107.50	2	113.10	
	high	107.50	high	113.10	
2	1	93.12	1	92.41	97.85
	2	100.10	2	95.60	
	high	100.10	high	95.60	
3	1	62.45	1	65.52	68.80
	2	66.49	2	71.11	
	high	66.49	high	71.11	

Table C.14 Adhesion strength of solder masks that used ammonium laurate 0.15 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO_2)

Amount of TiO_2 (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Adhesion strength (N)	specimen	Adhesion strength (N)	
1.25	1	131.10	1	142.10	
	2	137.60	2	147.40	
	high	137.60	high	147.40	142.50
2.50	The values are shown in Table C.13 at TMTD 2 phr				
3.75	1	83.16	1	93.69	
	2	90.16	2	97.96	
	high	90.16	high	97.96	94.03

Table C.15 Adhesion strength of solder masks that used Tergitol NP9 0.50 phr at various amounts of tetramethylthiuram disulfide (TMTD)

Amount of TMTD (phr)	1 st Experiment		2 nd Experiment		Average
	Specimen	Adhesion strength (N)	specimen	Adhesion strength (N)	
1	1	38.38	1	47.57	45.03
	2	41.96	2	48.10	
	high	41.96	high	48.10	
2	1	28.27	1	29.25	30.44
	2	28.72	2	32.16	
	high	28.72	high	32.16	
3	1	24.88	1	26.66	27.48
	2	26.53	2	28.42	
	high	26.53	high	28.42	

Table C.16 Adhesion strength of solder masks that used Tergitol NP9 0.50 phr, TMTD 2 phr at various amounts of titanium dioxide (TiO₂)

Amount of TiO ₂ (phr)	1 st Experiment		2 nd Experiment		Average
	specimen	Adhesion strength (N)	specimen	Adhesion strength (N)	
1.25	1	32.35	1	33.72	
	2	36.70	2	37.31	
	high	36.70	high	37.31	37.01
2.50	The values are shown in Table C.15 at TMTD 2 phr				
3.75	1	19.76	1	20.58	
	2	20.29	2	22.77	
	high	20.29	high	22.77	21.53

Appendix D

1. Viscosity of Solder Masks

Table D.1 Factors necessary to convert reading on scale 0-100 to millipascal seconds (centipoises) of Brookfield RVT small sample in spindle number 14

Speed (rpm)	Factor
100	125
50	250
20	625
10	1,250
5.5	2,500
4	3,125
2.5	5,000
2	6,250
1	12,500
0.5	25,000

Table D.2 Viscosity of solder masks at various amounts of carboxymethyl cellulose (CMC)

Amount of CMC (g)	1 st Experiment		2 nd Experiment		Average
	specimen	Viscosity (cps.)	specimen	Viscosity (cps.)	
5% CMC 20 g	1	11,562.5	1	11,687.5	
	2	11,500.0	2	11,812.5	
	3	11,687.5	3	11,750.0	
	mean	11,583.3	mean	11,750.0	11,666.7
5% CMC 25 g	1	12,750.0	1	12,625.0	
	2	13,062.5	2	12,687.5	
	3	13,125.0	3	12,812.5	
	mean	12,979.2	mean	12,708.3	12,843.8
6% CMC 20 g	1	15,937.5	1	15,625.0	
	2	15,812.5	2	15,625.0	
	3	15,625.0	3	15,750.0	
	mean	15,791.7	mean	15,666.7	15,729.2
6% CMC 25 g	1	19,187.5	1	19,125.0	
	2	19,375.0	2	19,187.5	
	3	19,437.5	3	19,375.0	
	mean	19,333.3	mean	19,229.2	19,281.3

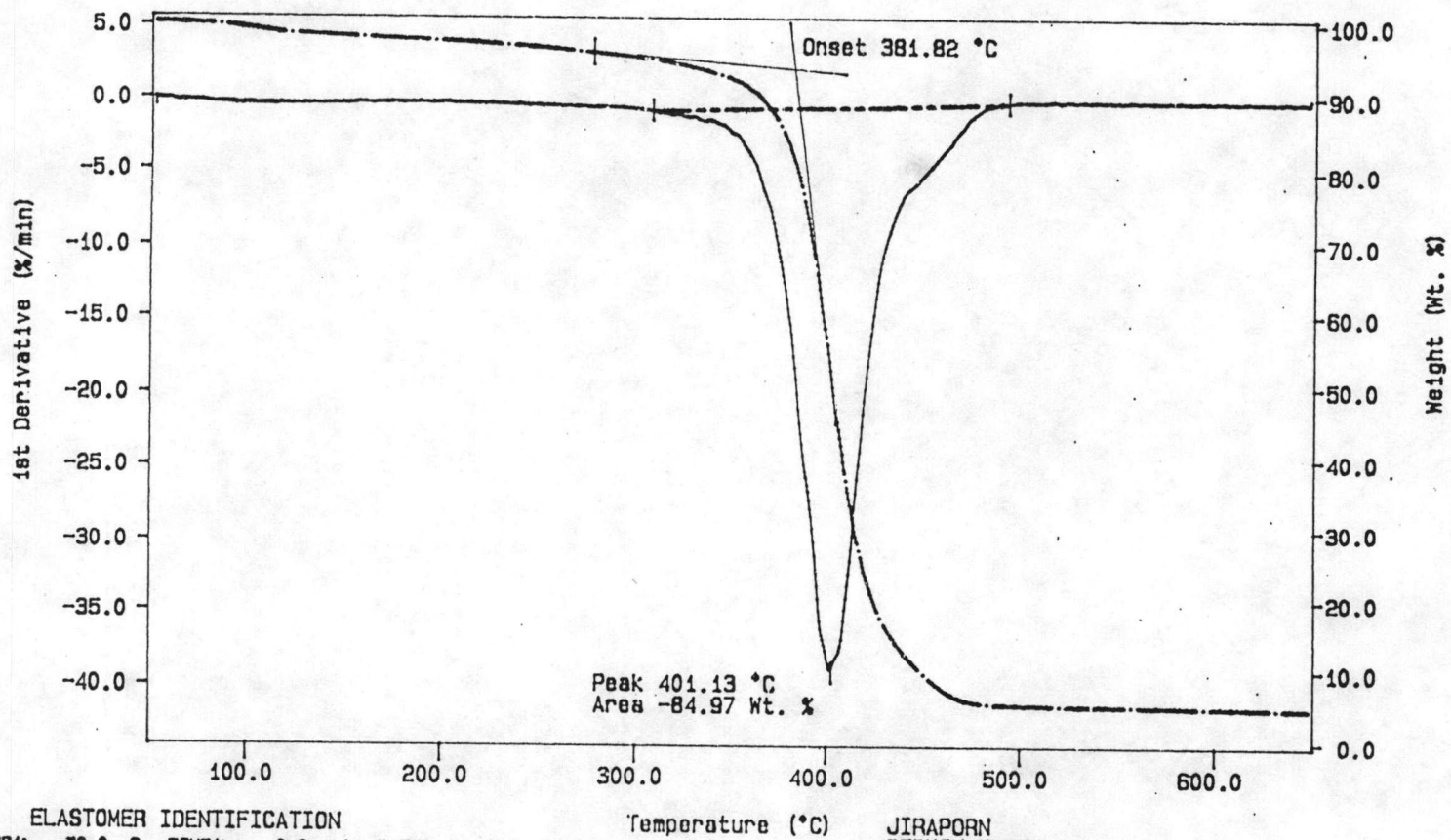
Amount of CMC (g)	1 st Experiment		2 nd Experiment		Average
	specimen	Viscosity (cps.)	specimen	Viscosity (cps.)	
7% CMC 20 g	1	20,812.5	1	21,125.0	
	2	21,375.0	2	21,250.0	
	3	21,375.0	3	21,250.0	
	mean	21,187.5	mean	21,208.3	21,197.9
7% CMC 25 g	1	26,562.5	1	26,437.5	
	2	26,687.5	2	26,437.5	
	3	26,687.5	3	26,562.5	
	mean	26,645.8	mean	26,479.2	26,562.5

Table D.3 Viscosity of solder masks at various time

Amount of CMC (g)	Weeks	Viscosity (cps.)			Average
		1	2	3	
5% CMC 20 g	0	11,687.5	11,812.5	11,750.0	11,750.0
	1	10,312.5	10,312.5	10,312.5	10,312.5
	2	10,125.0	10,187.5	10,187.5	10,166.7
	4	9,500.0	9,562.5	9,500.0	9,520.8
	6	9,062.5	9,375.0	9,187.5	9,208.3
	8	9,062.5	9,187.5	9,187.5	9,145.8

Amount of CMC (g)	Weeks	Viscosity (cps.)			Average
		1	2	3	
5% CMC 25 g	0	12,750.0	13,062.5	13,125.0	12,979.2
	1	11,875.0	12,000.0	12,125.0	12,000.0
	2	12,437.5	12,500.0	12,437.5	12,458.3
	4	11,250.0	11,312.5	11,312.5	11,291.7
	6	11,250.0	11,250.0	11,250.0	11,250.0
	8	11,375.0	11,312.5	11,250.0	11,312.5
	6% CMC 20 g	0	15,937.5	15,812.5	15,625.0
1	15,937.5	16,000.0	15,937.5	15,958.3	
2	15,375.0	15,437.5	15,750.0	15,520.8	
4	14,687.5	14,562.5	14,562.5	14,604.2	
6	14,812.5	14,937.5	14,875.0	14,875.0	
8	14,812.5	14,687.5	14,687.5	14,729.2	
6% CMC 25 g	0	19,187.5	19,375.0	19,437.5	19,333.3
1	19,125.0	19,312.5	19,312.5	19,250.0	
2	19,312.5	19,375.0	19,312.5	19,333.3	
4	17,500.0	17,375.0	17,312.5	17,395.8	
6	17,187.5	17,062.5	16,562.5	16,937.5	
8	17,062.5	17,062.5	16,937.5	17,020.8	

Amount of CMC (g)	Weeks	Viscosity (cps.)			Average
		1	2	3	
7% CMC 20 g	0	20,812.5	21,375.0	21,375.0	21,187.5
	1	21,875.0	22,187.5	21,812.5	21,958.3
	2	21,500.0	21,562.5	21,500.0	21,520.8
	4	20,000.0	19,875.0	19,687.5	19,854.2
	6	21,000.0	20,750.0	20,625.0	20,791.7
	8	20,687.5	20,875.0	20,937.5	20,833.3
7% CMC 25 g	0	26,562.5	26,687.5	26,687.5	26,645.8
	1	25,312.5	25,562.5	25,312.5	25,395.8
	2	26,750.0	26,562.5	26,437.5	26,583.3
	4	25,875.0	24,875.0	24,875.0	25,208.3
	6	25,812.5	25,875.0	25,250.0	25,645.8
	8	25,875.0	25,687.5	25,625.0	25,729.2



ELASTOMER IDENTIFICATION
 TEMP: 80.0 °C TIME: 0.0 min RATE: 20.0 C/min
 TEMP: 880.0 °C

JIRAPORN
 PERKIN-ELMER
 7 Series Thermal Analysis System
 Mon Nov 29 09:17:28 1999

Appendix E

Figure E.1 TG/DTG thermogram of solder mask that prepared from suitable formula of prevulcanized latex

VITA

Pornchai Kengpanyadee was born on September 19, 1975 in Bangkok, Thailand. He received his Bachelor Degree of Science in Chemistry, King Mongkut's Institute of Technology Thonburi in 1996. He began his Master Degree of Petrochemistry and Polymer Science, Graduate School Chulalongkorn University, in 1997 and completed the program in 1999.