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APPENDIX I

Results of Experiment

Compressive Properties of Rubber-filled Epoxy Systems

% Rubber	Compressive Modulus (GPa)	Compressive Yield Stress (MPa)	Fracture Strain (%)	No of Break Sample (pieces)
0%	1.98	93.5	13.5	10 from 10
5 % NBR	1.78	78.6	14.1	10 from 10
10% NBR	1.51	67.0	14.3	10 from 10
15% NBR	1.28	56.1	13.1	10 from 10
20% NBR	1.16	46.9	12.9	10 from 10
25% NBR	0.88	34.4	12.7	10 from 10
30% NBR	0.68	24.8	14.4	8 from 10
5 % TREATED NBR	1.73	74.2	13.8	9 from 10
10% TREATED NBR	1.40	68.1	16.6	10 from 10
15% TREATED NBR	1.19	55.3	14.6	10 from 10
20% TREATED NBR	1.04	45.1	13.4	10 from 10
25% TREATED NBR	0.84	37.2	14.2	10 from 10
30% TREATED NBR	0.62	29.6	13.6	10 from 10
1.5% CTBN (15% A.N.)	1.83	85.4	15.7	10 from 10
2.5% CTBN (15% A.N.)	1.74	91.8	24.2	10 from 10
3.5% CTBN (15% A.N.)	1.68	85.8	22.9	9 from 10
5 % CTBN (15% A.N.)	1.64	80.5	NB	5 from 10
10% CTBN (15% A.N.)	1.30	61.1	NB	(none)
15 % CTBN (15% A.N.)	1.10	37.3	NB	(none)
20% CTBN (15% A.N.)	0.78	31.1	NB	(none)
25 % CTBN (15% A.N.)	0.52	28.1	NB	(none)
2.5% CTBN (30% A.N.)	1.72	88.5	21.1	9 from 10
5 % CTBN (30% A.N.)	1.60	79.1	NB	(none)
7.5% CTBN (30% A.N.)	1.49	76.6	NB	(none)
10% CTBN (30% A.N.)	1.35	67.3	NB	(none)

Tensile Properties of Rubber-filled Epoxy Systems

% Rubber	Tensile Modulus (GPa)	0.2% Offset Yield Stress (MPa)	0.2% Offset Yield STrain (%)
0%	1.09	24.5	1.3
5 % NBR	1.08	22.8	1.5
10% NBR	0.96	15.9	1.7
15% NBR	0.89	16.0	1.8
20% NBR	0.79	13.1	1.9
25% NBR	0.60	10.3	1.6
30% NBR	0.51	8.7	1.8
5 % TREATED NBR	1.08	16.8	1.4
10% TREATED NBR	0.92	15.1	1.7
15% TREATED NBR	0.86	15.2	1.8
20% TREATED NBR	0.66	10.3	1.9
25% TREATED NBR	0.61	8.9	1.8
30% TREATED NBR	0.48	7.9	2.0
1.5% CTBN (15% A.N.)	1.08	23.9	1.6
2.5% CTBN (15% A.N.)	1.04	23.8	1.7
3.5% CTBN (15% A.N.)	1.09	20.2	1.5
5 % CTBN (15% A.N.)	1.03	20.3	1.8
10% CTBN (15% A.N.)	0.87	16.8	1.7
15 % CTBN (15% A.N.)	0.74	14.0	2.1
20% CTBN (15% A.N.)	0.72	10.0	1.9
25 % CTBN (15% A.N.)	0.57	9.1	2.0
2.5% CTBN (30% A.N.)	1.06	21.7	1.8
5 % CTBN (30% A.N.)	1.00	20.4	1.7
7.5% CTBN (30% A.N.)	0.98	14.6	1.9
10% CTBN (30% A.N.)	0.92	13.9	2.2

Izod Impact Strength of Rubber-filled Epoxy Systems

% Rubber	Average Impact Strength I.S. (J/m)
0%	30.4
5 % NBR	20.2
10% NBR	18.0
15% NBR	20.0
20% NBR	22.4
25% NBR	25.6
30% NBR	29.1
5 % TREATED NBR	26.3
10% TREATED NBR	20.6
15% TREATED NBR	22.2
20% TREATED NBR	23.6
25% TREATED NBR	27.4
30% TREATED NBR	29.9
1.5% CTBN (15% A.N.)	21.7
2.5%CTBN (15% A.N.)	32.0
3.5% CTBN (15% A.N.)	31.1
5 % CTBN (15% A.N.)	31.3
10% CTBN (15% A.N.)	32.0
15% CTBN (15% A.N.)	34.9
20% CTBN (15% A.N.)	32.3
25% CTBN (15% A.N.)	
2.5% CTBN (30% A.N.)	35.5
5 % CTBN (30% A.N.)	33.6
7.5% CTBN (30% A.N.)	36.1
10% CTBN (30% A.N.)	40.5

Falling Weight Properties of Rubber-filled Epoxy Systems

% Rubber	Energy (J)	Deformation (mm)
0%	0.43	7.2
5% NBR	0.79	8.0
10% NBR	0.64	7.7
15% NBR	0.83	8.5
20% NBR	0.97	9.1
25% NBR	1.74	14.1
30% NBR	1.43	15.2
5% Tr. NBR	0.70	7.3
10% Tr. NBR	0.91	7.9
15% Tr. NBR	0.76	7.7
20% Tr. NBR	1.10	11.6
25% Tr. NBR	1.64	18.7
30% Tr. NBR	1.52	17.7
1.5% CTBN (15% A.N.)	0.46	6.0
2.5% CTBN (15% A.N.)	0.60	7.5
3.5% CTBN (15% A.N.)	0.50	6.4
5% CTBN (15% A.N.)	0.85	9.1
10% CTBN (15% A.N.)	0.74	9.1
15% CTBN (15% A.N.)	0.83	8.2
20% CTBN (15% A.N.)	1.71	12.7
25% CTBN (15% A.N.)	1.85	10.0
2.5% CTBN (30% A.N.)	0.68	6.7
5% CTBN (30% A.N.)	0.90	9.4
7.5% CTBN (30% A.N.)	0.81	10.0
10% CTBN (30% A.N.)	1.23	12.1

Double Torsion Properties of Rubber-filled Epoxy Systems

% Rubber	K_{IC} (MN/m^(3/2))	G_{IC} (J/m^2)
0%	1.10	614.0
5 % NBR	1.00	562.2
10% NBR	1.38	1262.5
15% NBR	1.46	1653.7
20% NBR	1.49	1920.4
25% NBR	1.50	2563.9
30% NBR	1.42	2975.9
5 % TREATED NBR	1.42	1170.1
10% TREATED NBR	1.37	1329.2
15% TREATED NBR	1.45	1765.1
20% TREATED NBR	1.52	2203.9
25% TREATED NBR	1.52	2733.0
30% TREATED NBR	1.56	3944.8
1.5% CTBN (15% A.N.)	1.76	1684.4
2.5% CTBN (15% A.N.)	1.60	1466.7
3.5% CTBN (15% A.N.)	2.21	2916.2
5 % CTBN (15% A.N.)	1.71	1791.5
10% CTBN (15% A.N.)	1.69	2194.5
15 % CTBN (15% A.N.)	1.70	2646.5
20% CTBN (15% A.N.)	2.08	5599.4
25 % CTBN (15% A.N.)	1.50	4311.3
2.5% CTBN (30% A.N.)	1.72	1717.0
5 % CTBN (30% A.N.)	1.73	1872.7
7.5% CTBN (30% A.N.)	2.60	4548.3
10% CTBN (30% A.N.)	2.45	4452.1

Density of Rubber-filled Epoxy Systems

% Rubber	Density (g/cc)
0%	1.20
5 % NBR	1.18
10% NBR	1.16
15% NBR	1.14
20% NBR	1.12
25% NBR	1.09
30% NBR	1.05
5 % TREATED NBR	1.18
10% TREATED NBR	1.17
15% TREATED NBR	1.15
20% TREATED NBR	1.13
25% TREATED NBR	1.11
30% TREATED NBR	1.09
1.5% CTBN (15% A.N.)	1.20
2.5% CTBN (15% A.N.)	1.20
3.5% CTBN (15% A.N.)	1.20
5 % CTBN (15% A.N.)	1.19
10% CTBN (15% A.N.)	1.18
15 % CTBN (15% A.N.)	1.15
20% CTBN (15% A.N.)	1.15
25 % CTBN (15% A.N.)	1.12
2.5% CTBN (30% A.N.)	1.20
5 % CTBN (30% A.N.)	1.19
7.5% CTBN (30% A.N.)	1.19
10% CTBN (30% A.N.)	1.17

Tg from DSC Test of Rubber-filled Epoxy Systems

% Rubber	Glass Transition Temperature Tg (C)
0%	117.0
5 % NBR	117.7
10% NBR	118.0
15% NBR	120.7
20% NBR	113.2
25% NBR	122.0
30% NBR	121.6
5 % TREATED NBR	119.0
10% TREATED NBR	118.4
15% TREATED NBR	128.5
20% TREATED NBR	127.4
25% TREATED NBR	127.2
30% TREATED NBR	123.6
1.5% CTBN (15% A.N.)	119.1
2.5% CTBN (15% A.N.)	118.7
3.5% CTBN (15% A.N.)	116.6
5 % CTBN (15% A.N.)	111.3
10% CTBN (15% A.N.)	99.8
15 % CTBN (15% A.N.)	93.0
20% CTBN (15% A.N.)	108.8
25 % CTBN (15% A.N.)	104.2
2.5% CTBN (30% A.N.)	116.5
5 % CTBN (30% A.N.)	113.5
7.5% CTBN (30% A.N.)	104.0
10% CTBN (30% A.N.)	105.3

Properties from DMTA Test of Rubber-filled Epoxy Systems

% Rubber	Tg of Rubber (C)	Tg of Epoxy (C)	Bending Modulus E' (MPa)	Molecular weight between Crosslinks Mc, (g/mol)	Strand density (m^3) *10^27
0%	-	138.12	44	302.2	6.741
5 % NBR	-17.54	135.86	34	328.7	5.209
10% NBR	-16.03	139.92	32	330.6	4.902
15% NBR	-17.26	140.88	23	376.9	3.524
20% NBR	-16.03	133.04	13	513.9	1.992
25% NBR	-16.14	143.86	10	608.6	1.532
30% NBR	-16.12	139.64	10	590.1	1.532
5 % TREATED NBR	-18.08	138.68	38	314.1	5.822
10% TREATED NBR	-17.8	138.48	25	372.3	3.830
15% TREATED NBR	-17.69	144.68	21	400.1	3.217
20% TREATED NBR	-14.53	143.08	20	400.1	3.064
25% TREATED NBR	-15.57	142.64	13	510.2	1.992
30% TREATED NBR	-14.44	142.12	12	531.4	1.838
1.5% CTBN (15% A.N.)	-38.17	139.38	48	291.0	7.354
2.5% CTBN (15% A.N.)	-32.84	139.82	44	300.5	6.741
3.5% CTBN (15% A.N.)	-36.55	140.12	45	297.7	6.894
5 % CTBN (15% A.N.)	-35.16	134.46	39.5	312.2	6.051
10% CTBN (15% A.N.)	-37.22	115.36	22	398.2	3.370
15 % CTBN (15% A.N.)	-34.75	131.54	27	354.0	4.136
20% CTBN (15% A.N.)	-38.07	122.74	25	364.3	3.830
25 % CTBN (15% A.N.)	-34.96	134.58	13	515.8	1.992
2.5% CTBN (30% A.N.)	-35.2	143.6	42	305.7	6.434
5 % CTBN (30% A.N.)	-35.78	141.24	42	305.0	6.434
7.5% CTBN (30% A.N.)	-37.53	135.78	31	343.5	4.749
10% CTBN (30% A.N.)	-38.23	132.54	32	333.2	4.902

VITA

Mr. Anawat Chansaksoong was born in Phuket, a province in the southern part of Thailand, on June 10, 1973. He graduated from Taesabarn Banbangneaw Primary School in 1985 and from Phuket Wittayalai Secondary School in 1988. He spent two years at Triamudomsuksa school. In 1994 he graduated from the Faculty of Engineering, Chulalongkorn University with a major in Chemical Engineering. After graduation, he pursues his graduate study in Chemical Engineering at the Faculty of Engineering, Chulalongkorn University.