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APPENDICES

Appendix A The Calibration Curve of GPC

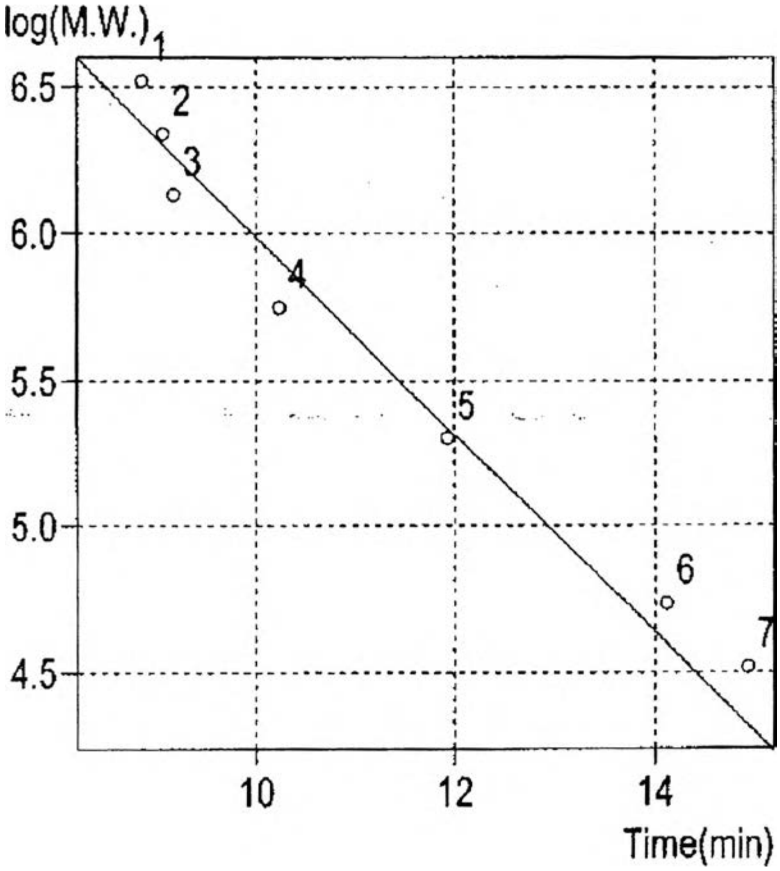

Figure A1 Calibration curve of GPC.

Table A1 Calibration curve of GPC

Time (min)	Log (M.W.)
8.8	6.51
9	6.3
9.2	6.1
10.3	5.73
11.9	5.3
14.1	4.7
15	4.5

Appendix B ^{1}H NMR Results of OPV

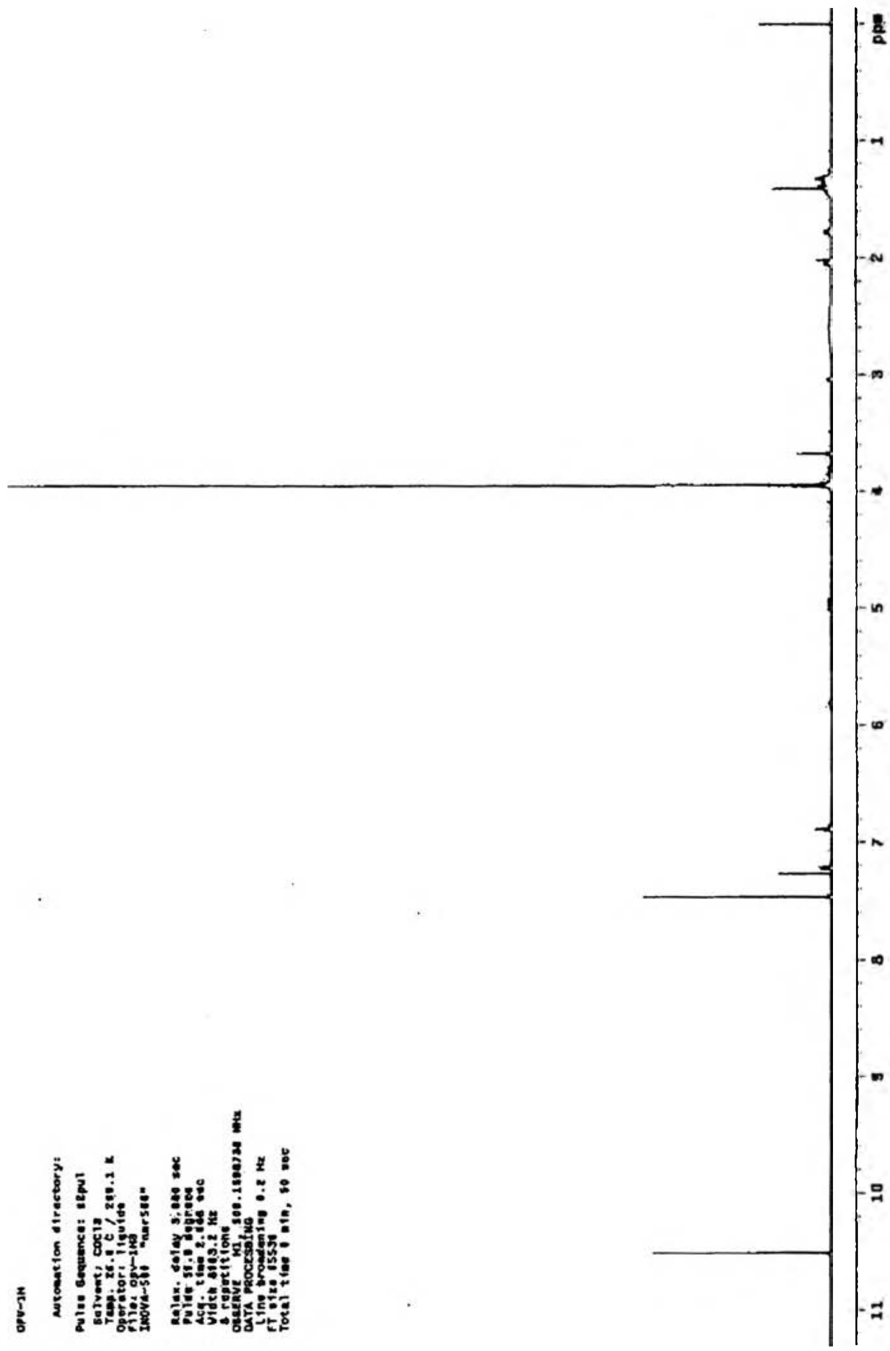

Figure B1 ^{1}H NMR of OPV.

Appendix C Characterization of Natural Rubber

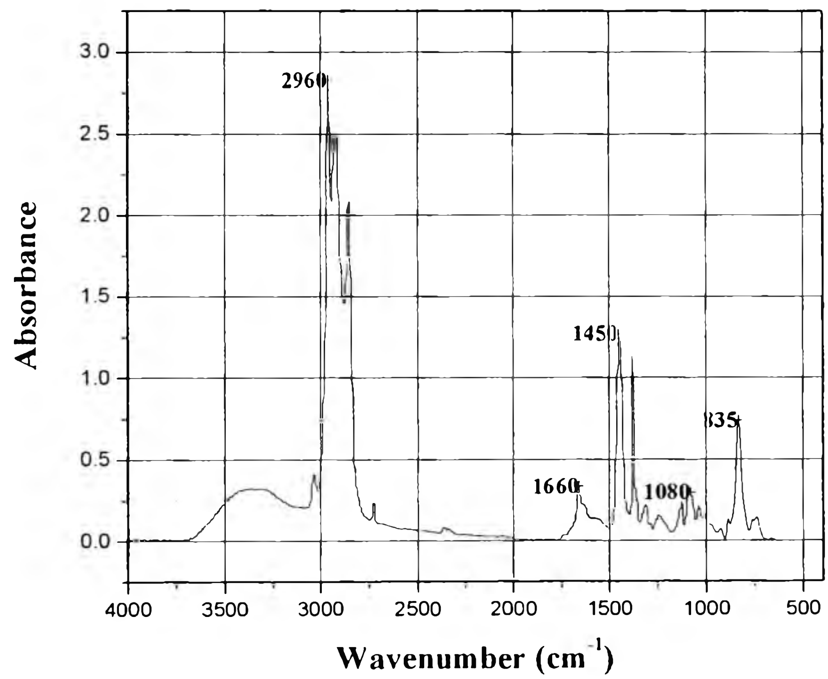

Figure C1 FT-IR of natural rubber.

Table C1 FT-IR peak assignments for the IR absorption band

Wavenumber (cm^{-1})	Assignment
Isoprene	
3033	=CH stretching
2962	C-H stretching of CH_3
2927	C-H stretching of CH_2
2855	C-H stretching of CH_2 and CH_3
1664	C=C stretching
1450	C-H bending of CH_2
1375	C-H bending of CH_3
1127	C-H bending
837	C=CH wagging
Protein/phospholipids	
3440	-OH stretching
3280	N-H stretching
1737	C=O stretching
1548	N-H bending
1080	C-O
1041	-O-O-

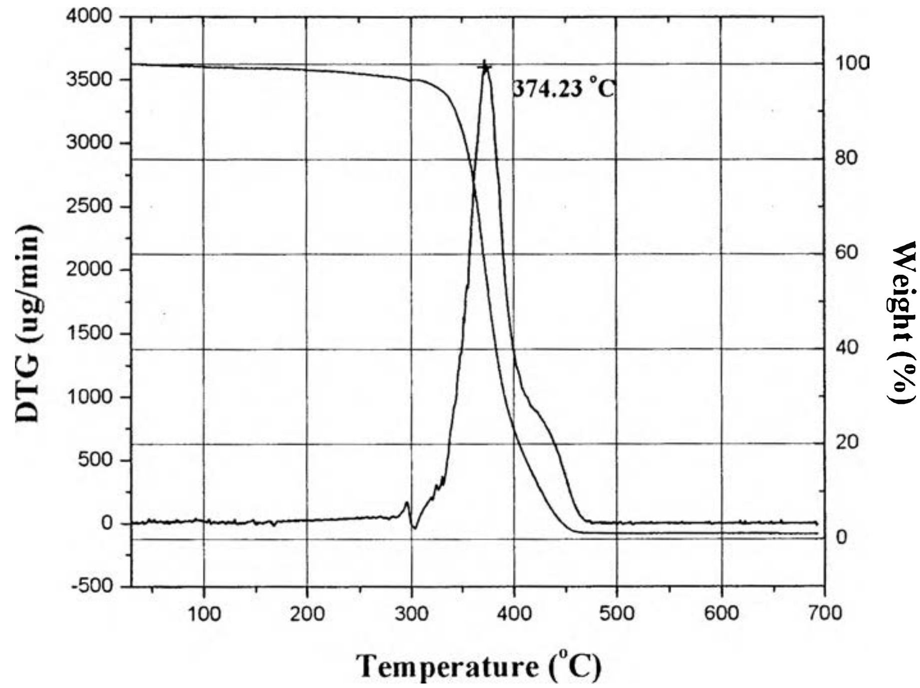

Figure C2 Thermal gravimetric analysis curve of natural rubber.

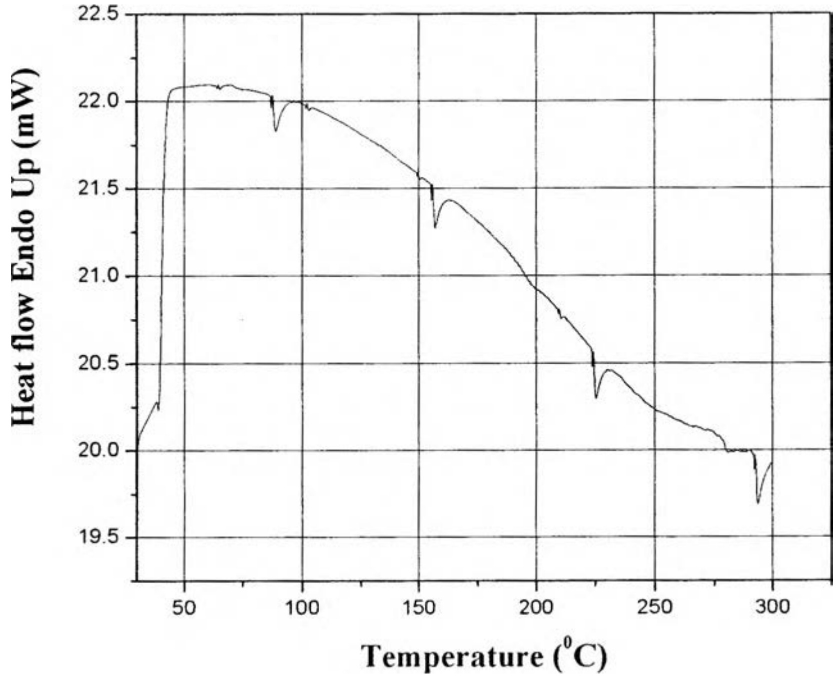

Figure C3 DSC thermogram of natural rubber. The thermogram was obtained from the scan rate was 10°C.

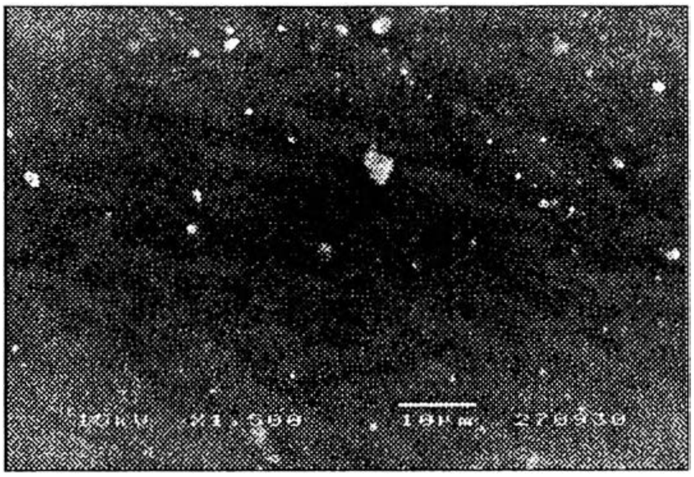

Figure C4 SEM micrograph of the surface of natural rubber.

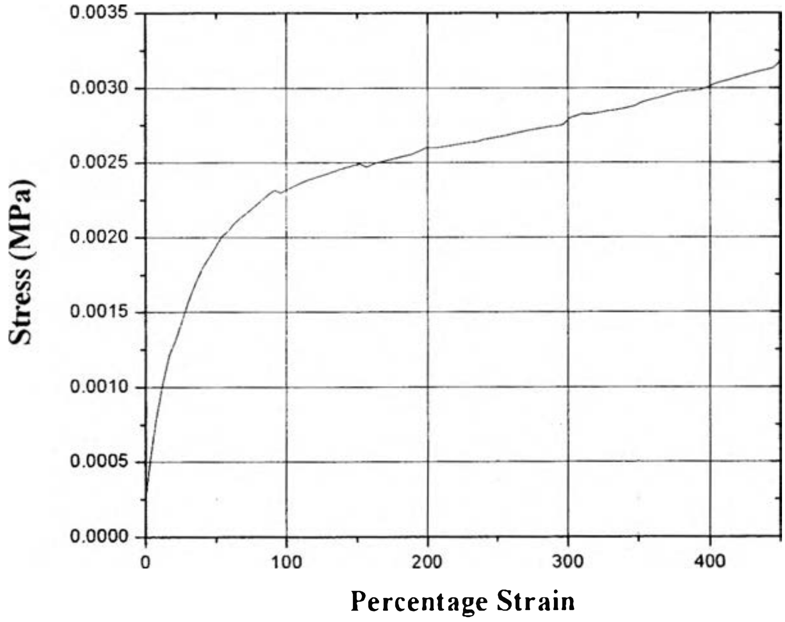

Figure C5 Stress-Strain curve of natural rubber.

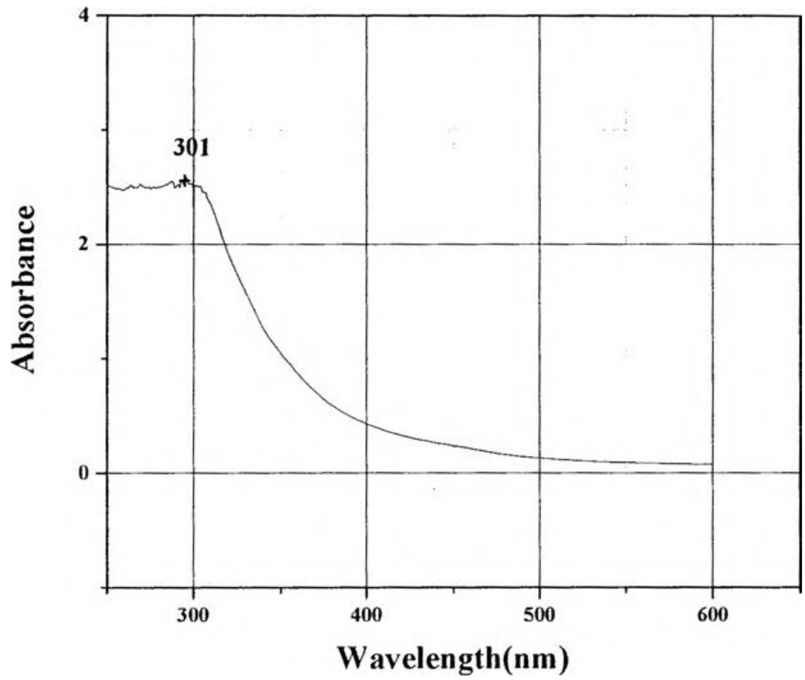

Figure C6 UV-Vis absorption spectrum of natural rubber film.

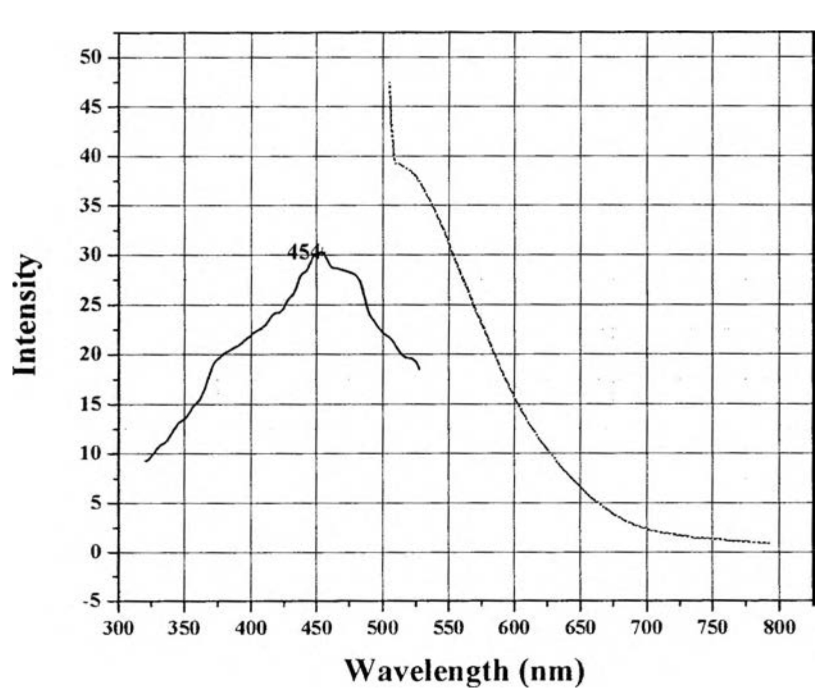

Figure C7 PL spectra of natural rubber film, λ_{ex}= 520 nm.

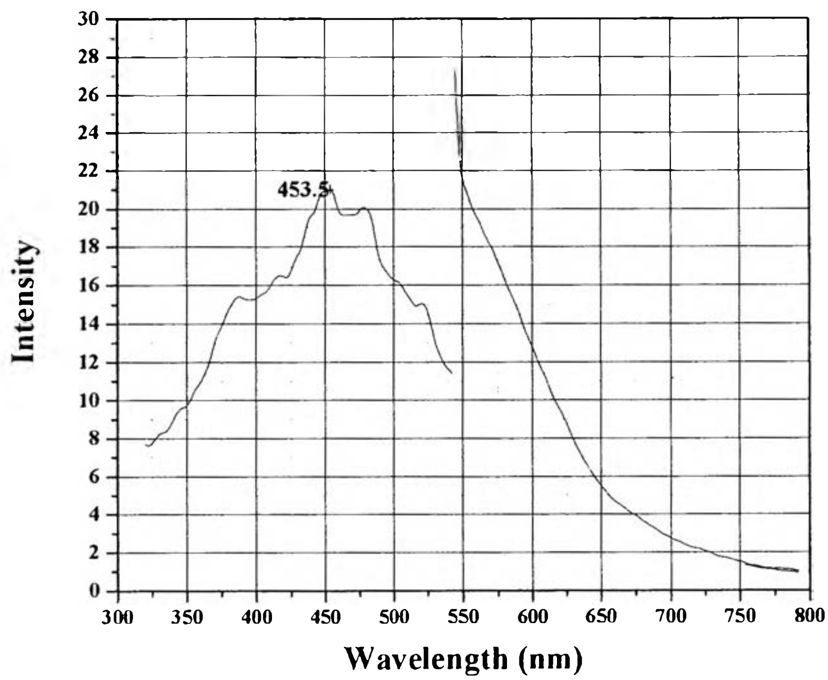

Figure C8 PL spectra of natural rubber film, λ_{ex}= 480 nm

Appendix D ^{1}H NMR Results of PPV-g-NR

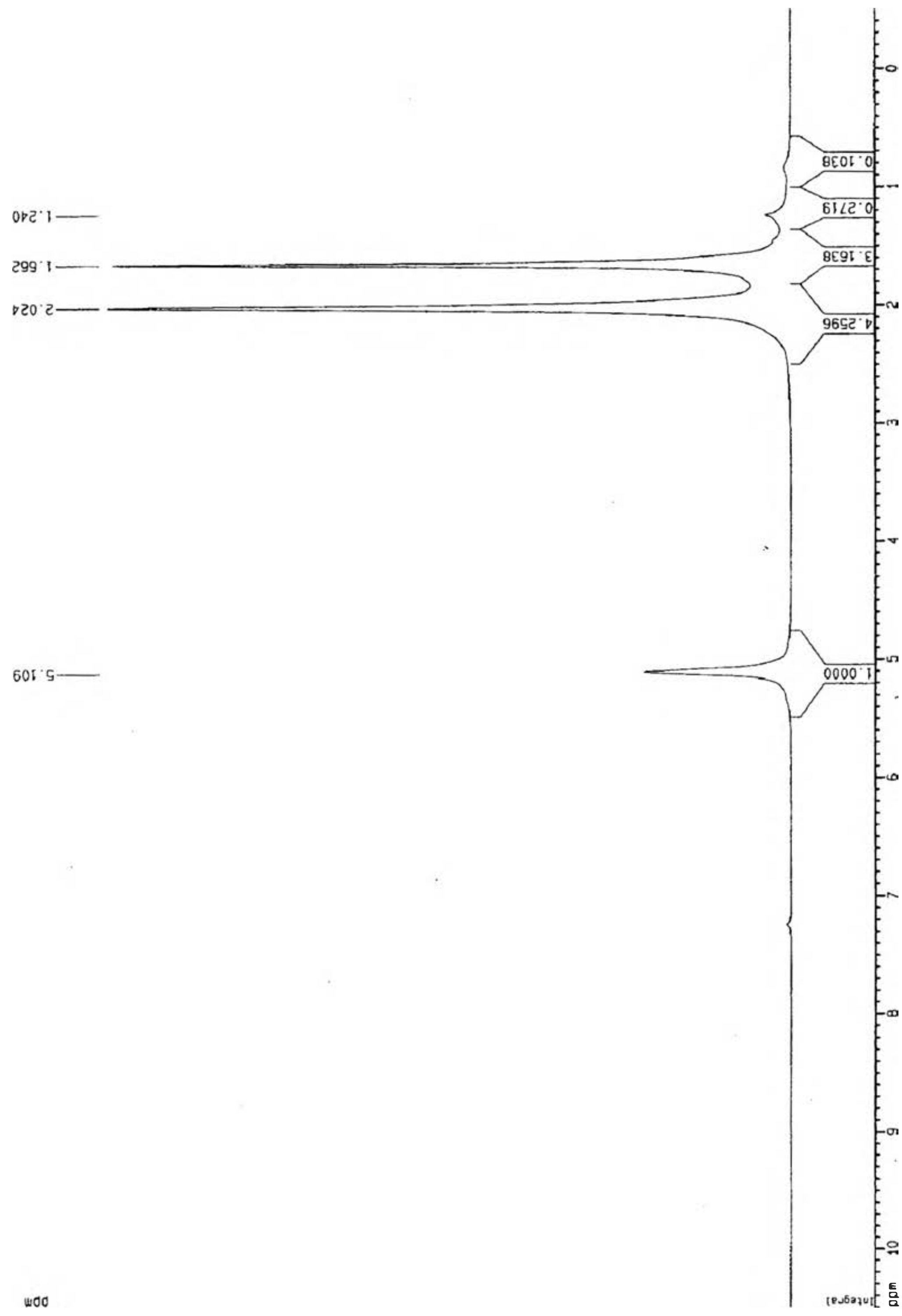

Figure D1 ^{1}H NMR of natural rubber filled with PPV 3 wt%.

Appendix E ¹H NMR Results of OPV-g-NR

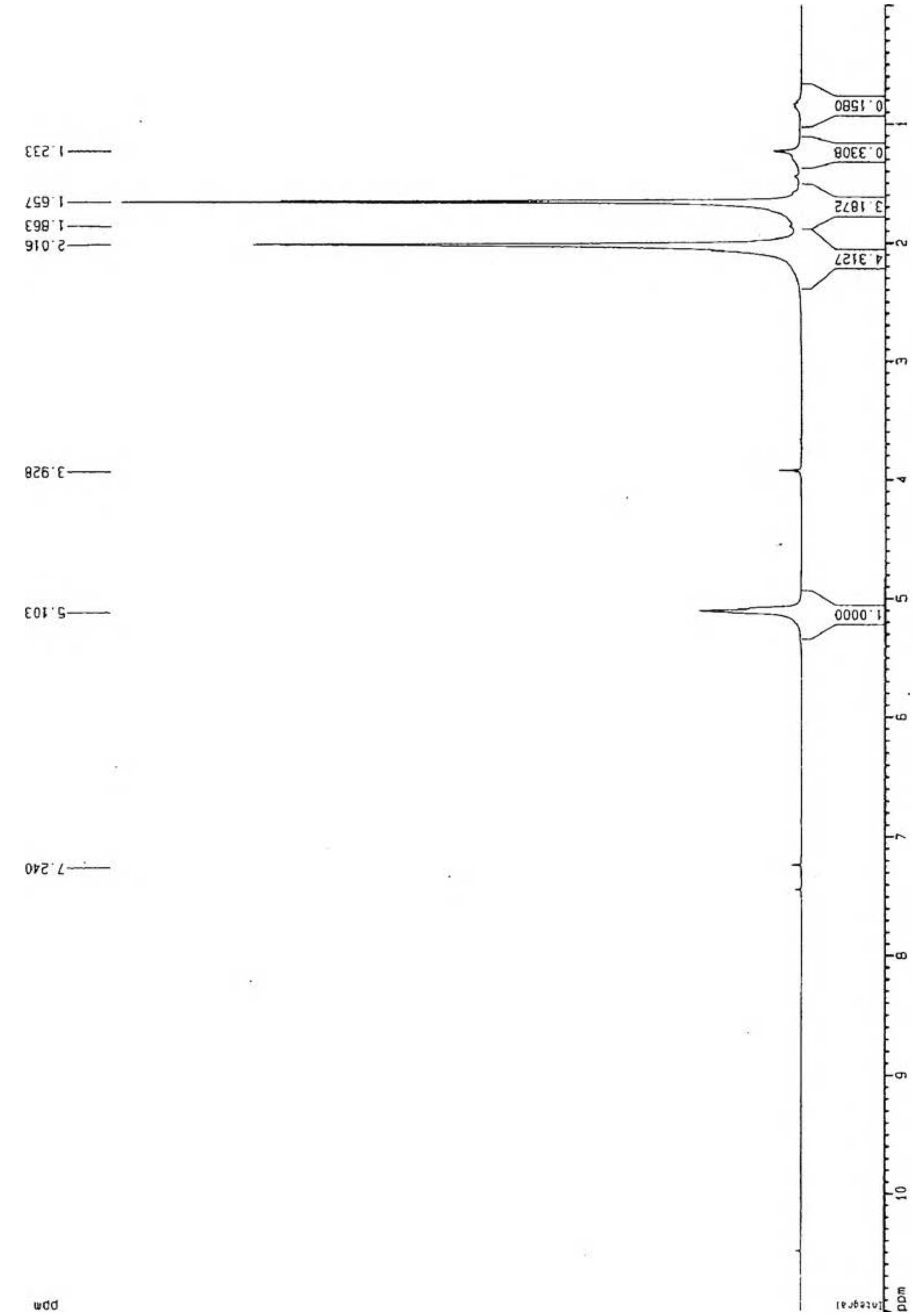

Figure E1 ¹H NMR of natural rubber filled with OPV 3 wt%.

Appendix F DSC Results of Copolymers

The thermal properties of copolymers that have natural rubber in the composition have to use DSC to find the effect of dye molecules.

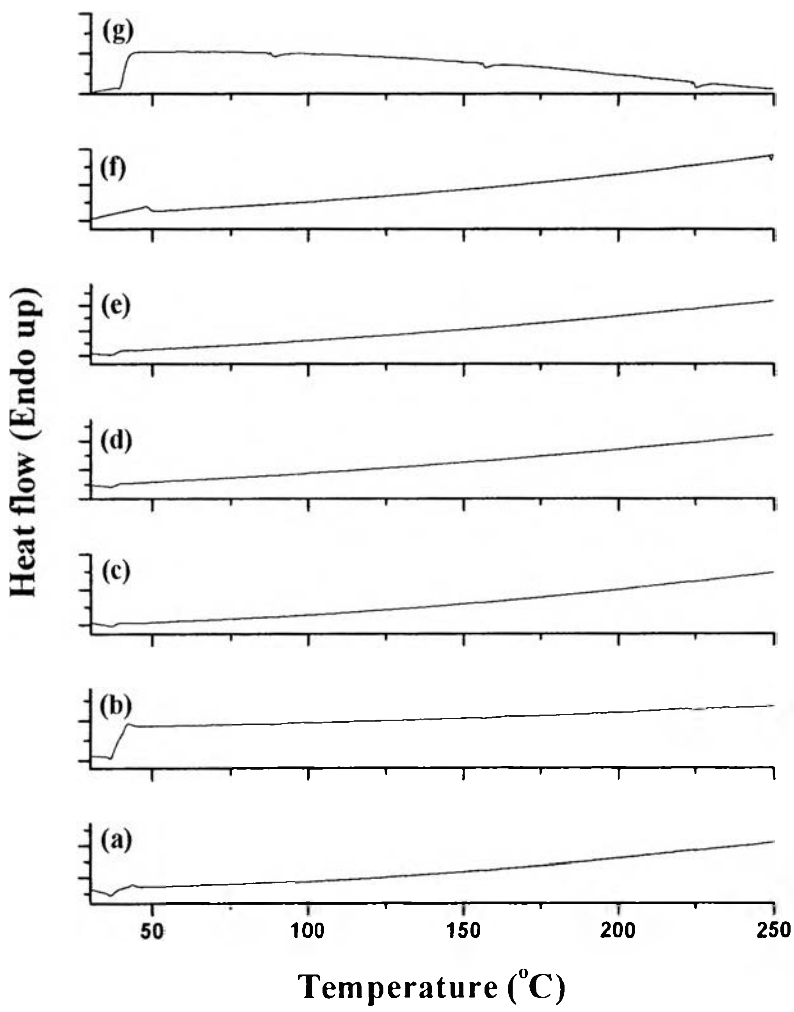

Figure F1 DSC spectra of (a) NR, NR-g-PPV (b) 0.5%, (c) 1 %, (d) 2%, (e) 3%, (f) 4 wt%, and (g) PPV.

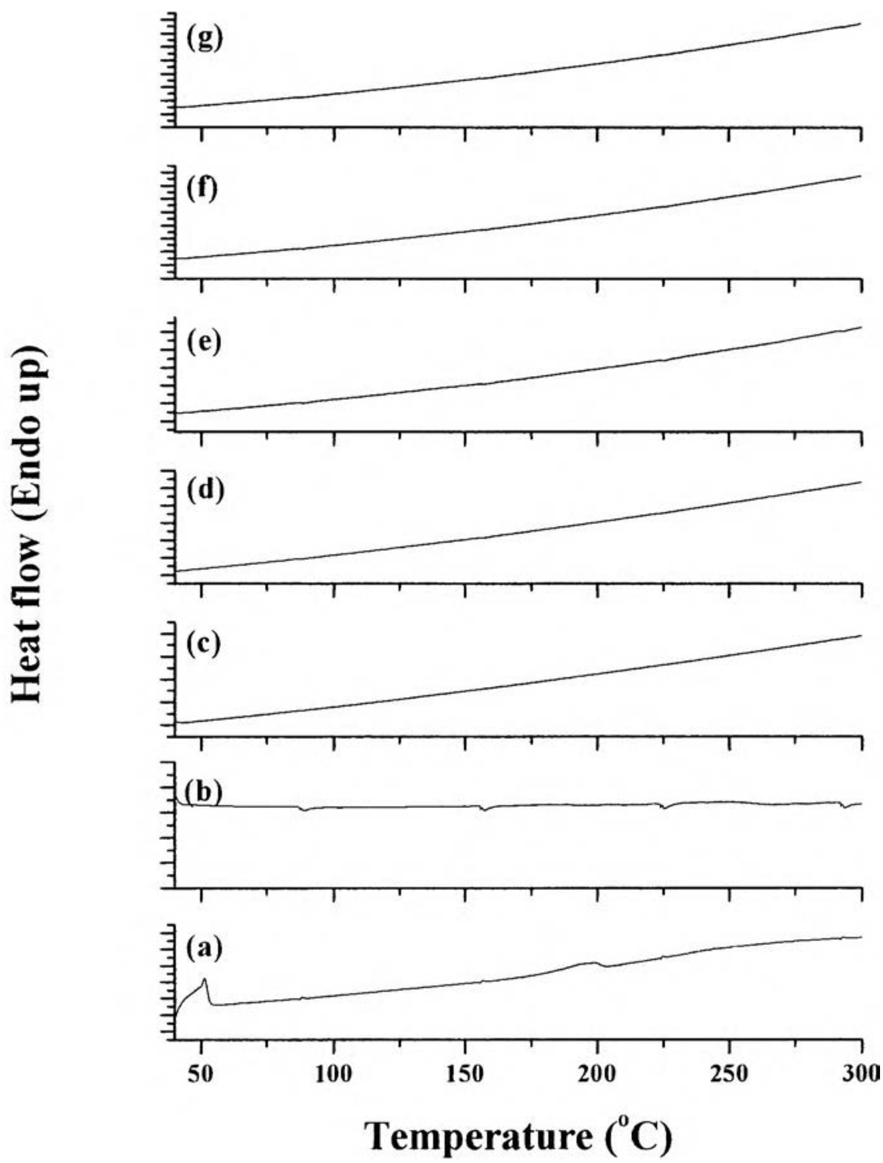

Figure F2 DSC spectra of natural rubber filled with OPV (a) 0%, (b) 0.5%, (c) 1 %, (d) 2%, (e) 3%, and (f) 4 wt%, and (g) OPV powder.

Appendix G Molecular Weight of Products

Molecular weights of PPV, OPV, Natural rubber, and copolymers can be estimated by using GPC. The results are shown in the bottom tables.

Table G1 Molecular weight test of natural rubber

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	111,299	1,255			1,495
Mw	530,006	2,960			88,288
Mz	2.05867E+06	8,828			2.00107E+06
Mz1	3.77093E+06	16,508			3.77047E+06
Mw/Mn	4.76201	2.35823			59.07354
Mv/Mn	0.00000	0.00000			0.00000
Mz/Mw	3.98224	2.98224			22.66520

Table G2 Molecular weight test of natural rubber filled with PPV 0.5 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	116,624	2,804	1.447	358	1,037
Mw	561,933	3,851	1,176	476	171,174
Mz	1.42182E+06	6,005	1,204	570	1.40978E+06
Mz1	2.05283E+06	9,026	1,231	635	2.05277E+06
Mw/Mn	4.81832	1.37372	1.02457	1.33103	165.11750
Mv/Mn	0.00000	0.00000	0.00000	0.00000	0.00000
Mz/Mw	2.53023	1.55926	1.02394	1.19701	8.23595

Table G3 Molecular weight test of natural rubber filled with PPV 1 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	103,290	1,799	370		827
Mw	337,828	2,754	439		80,877
Mz	700,410	5,155	522		688,579
Mz1	983,361	8,887	580		983,248
Mw/Mn	3.27068	1.53090	1.33178		97.80661
Mv/Mn	0.00000	0.00000	0.00000		0.00000
Mz/Mw	2.07327	1.87197	1.18934		8.51388

Table G4 Molecular weight test of natural rubber filled with PPV 2 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	3.91230E+08	1.44777E+07	415,570	1,028	1,553
Mw	5.88236E+08	3.39815E+07	1.17054E+06	4,514	8.78326E+07
Mz	8.00310E+08	6.13631E+07	2.19915E+06	26,665	7.73321E+08
Mz1	9.87522E+08	7.87676E+07	2.86068E+06	55,531	9.84995E+08
Mw/Mn	1.50356	2.34716	2.81670	4.39197	56,563.25722
Mv/Mn	0.00000	0.00000	0.00000	0.00000	0.00000
Mz/Mw	1.36053	1.80578	1.87875	5.90762	8.80449

Table G5 Molecular weight test of natural rubber filled with PPV 3 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	142,883	1,854	318		955
Mw	370,500	3,530	418		56,310
Mz	760,977	9,302	487		730,053
Mz1	1.11105E+06	18,042	534		1.1105E+06
Mw/Mn	2.59303	1.90388	1.31262		58.97725
Mv/Mn	0.00000	0.00000	0.00000		0.00000
Mz/Mw	2.05392	2.63502	1.16691		12.96494

Table G6 Molecular weight test of natural rubber filled with PPV 4 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	139,408	926			1,088
Mw	372,335	2,824			58,309
Mz	734,173	8,075			704,288
Mz1	1.00515E+06	16,072			1.00468E+06
Mw/Mn	2.67082	3.05094			53.59866
Mv/Mn	0.00000	0.00000			0.00000
Mz/Mw	1.97181	2.85943			12.07848

Table G7 Molecular weight test of natural rubber filled with OPV 0.5 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	117,904	768			970
Mw	515,464	1,339			109,155
Mz	1.25155E+06	2,313			1.23946E+06
Mz1	2.07568E+06	3,966			2.06565E+06
Mw/Mn	4.37189	1.73942			112.47996
Mv/Mn	0.00000	0.00000			0.00000
Mz/Mw	2.42801	1.73064			11.35512

Table G8 Molecular weight test of natural rubber filled with OPV 1 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	54,013	959			2,247
Mw	1.29535E+06	2,578			756,774
Mz	6.82408E+06	4,440			6.81440E+06
Mz1	1.10946E+06	5,848			1.10946E+07
Mw/Mn	23.98234	2.68748			336.80918
Mv/Mn	0.00000	0.00000	0.00000	0.00000	0.00000
Mz/Mw	5.26815	1.72206			9.00454

Table G9 Molecular weight test of natural rubber filled with OPV 2 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	2.16869E+06	72,634	2,294	316	515
Mw	2.34512E+06	253,159	3,580	519	66,733
Mz	2.53898E+06	642,745	6,987	720	1.82402E+06
Mz1	2.73864E+06	896,531	11,610	859	2.51251E+06
Mw/Mn	1.08135	3.48540	1.56063	1.64326	129.70183
Mv/Mn	0.00000	0.00000	0.00000	0.0000	0.00000
Mz/Mw	1.08267	2.53890	1.95153	1.38895	27.33322

Table G10 Molecular weight test of natural rubber filled with OPV 3 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	1.73087E+06	62,124	557		624
Mw	1.94864E+06	211,511	1,180		49,536
Mz	2.22590E+06	499,608	3,038		1.48437E+06
Mz1	2.53763+06	695,260	6,411		2.28811E+06
Mw/Mn	1.12582	3.46035	2.11944		79.35951
Mv/Mn	0.00000	0.00000	0.00000	0.00000	0.00000
Mz/Mw	1.14228	2.36209	2.57472		29.96573

Table G11 Molecular weight test of natural rubber filled with OPV 4 wt%

	Peak No.1	Peak No.2	Peak No.3	Peak No.4	Average
Mn	1.94146E+06	61,985	934		1,115
Mw	2.10079E+06	211,926	1,611		62,436
Mz	2.28214E+06	481,807	2,538		1.31206E+06
Mz1	2.47813E+06	708,954	3,921		2.14570E+06
Mw/Mn	1.08206	3.41900	1.72466		55.97865
Mv/Mn	0.00000	0.00000	0.00000	0.00000	0.00000
Mz/Mw	1.08633	2.27347	1.57478		21.01453

Appendix H Optical Microscope Picture of Copolymers

The copolymer film was fabricated by dropping copolymer solution on glass substrates and drying in air for 12 hours. Those films were observed by optical microscope. It is used for microscopic observations and to obtain optical micrographs of the surfaces. The used magnification level (combined with eye-piece magnification) is 50X. Its magnification can be further enhanced by taking a digital image and zooming it with image software.

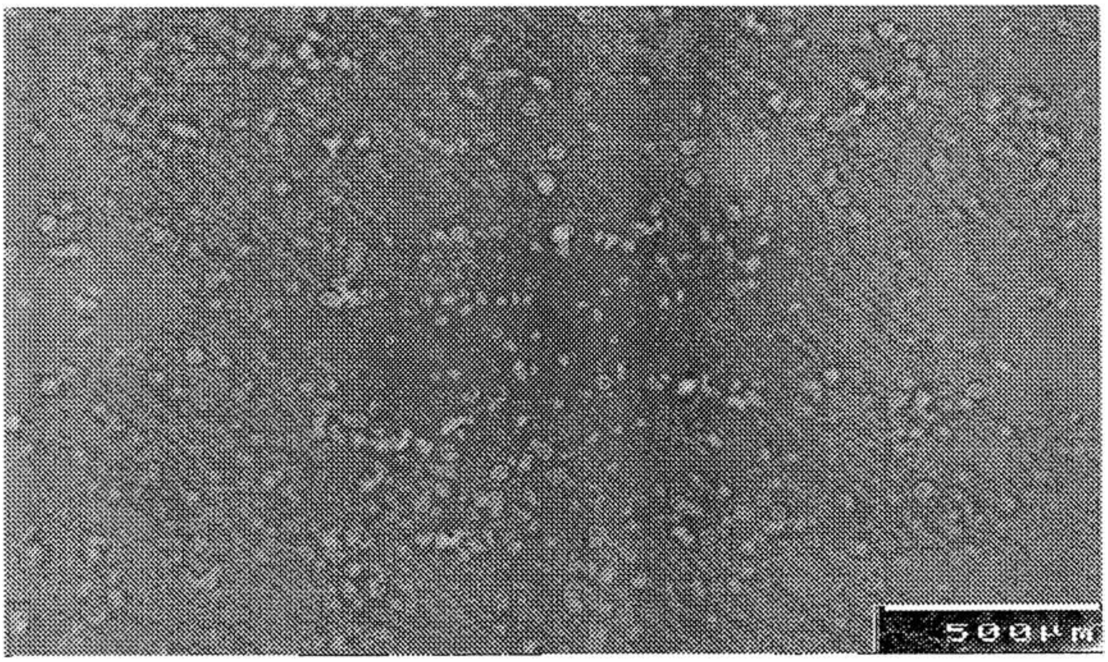

Figure H1 Optical microscope picture of natural rubber.

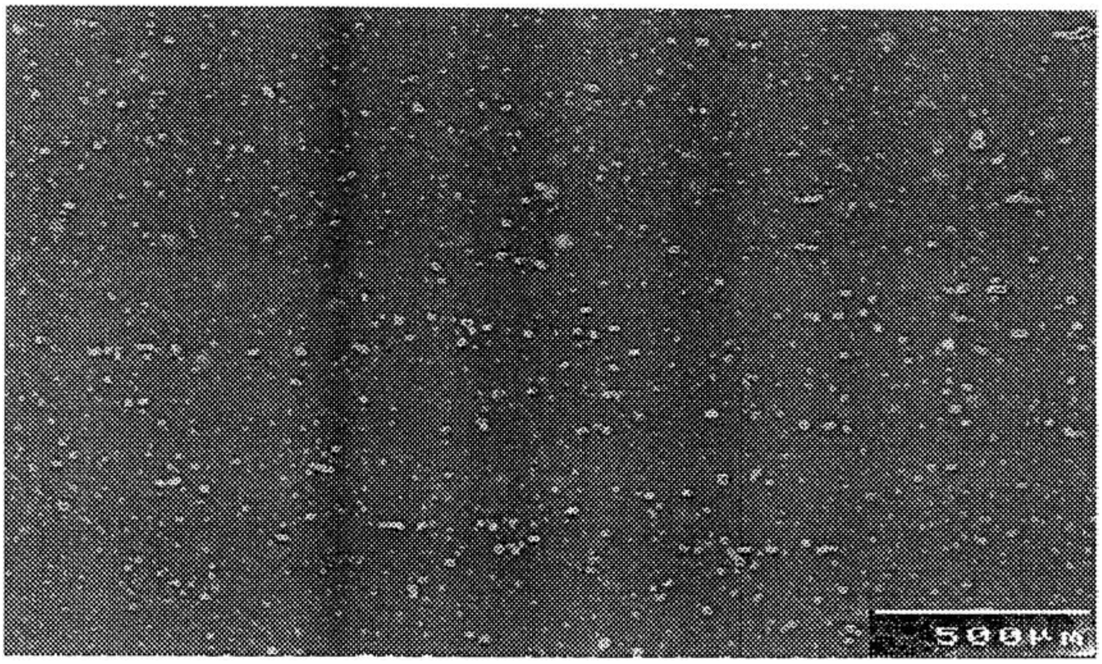

Figure H2 Optical microscope picture of natural rubber filled with PPV 0.5 wt%.

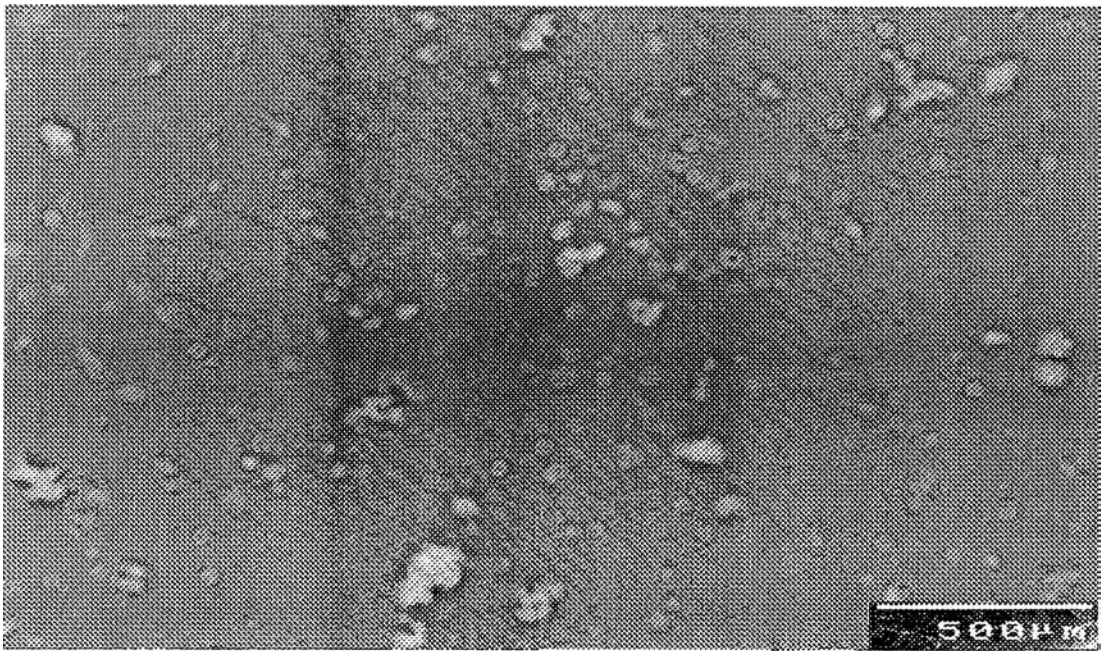

Figure H3 Optical microscope picture of natural rubber filled with PPV 1 wt%.

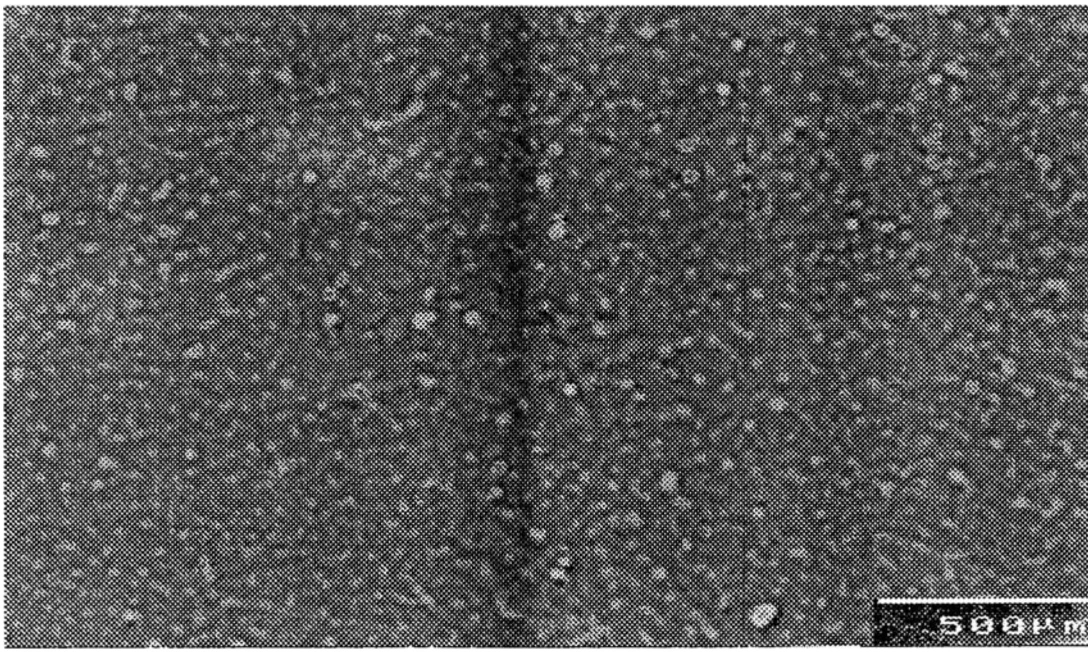

Figure H4 Optical microscope picture of natural rubber filled with PPV 2 wt%.

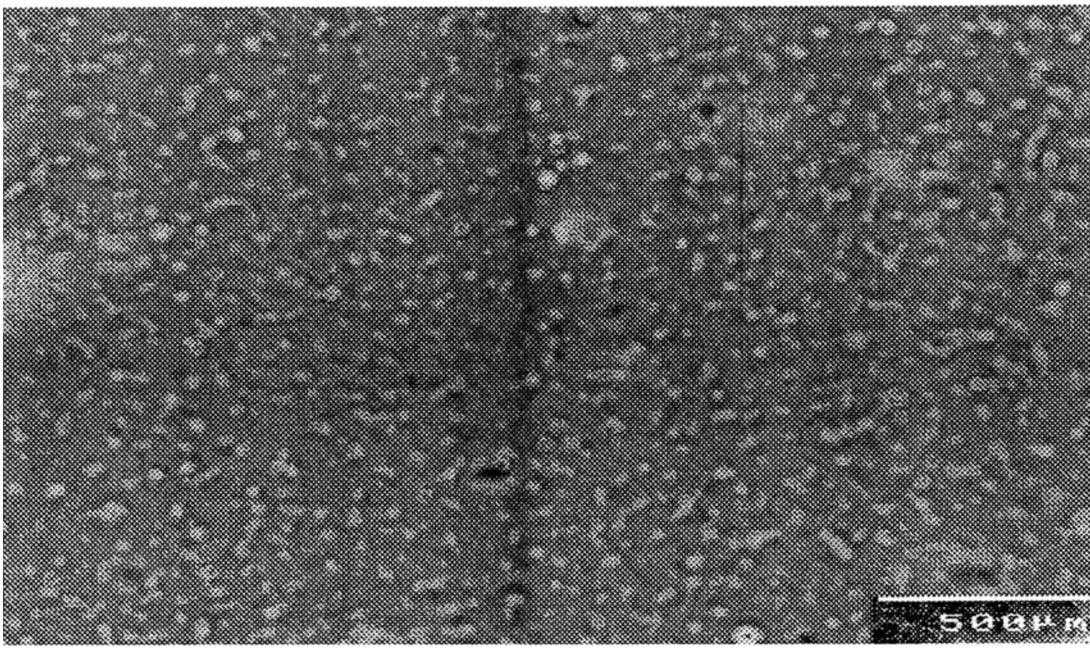

Figure H5 Optical microscope picture of natural rubber filled with PPV 3 wt%.

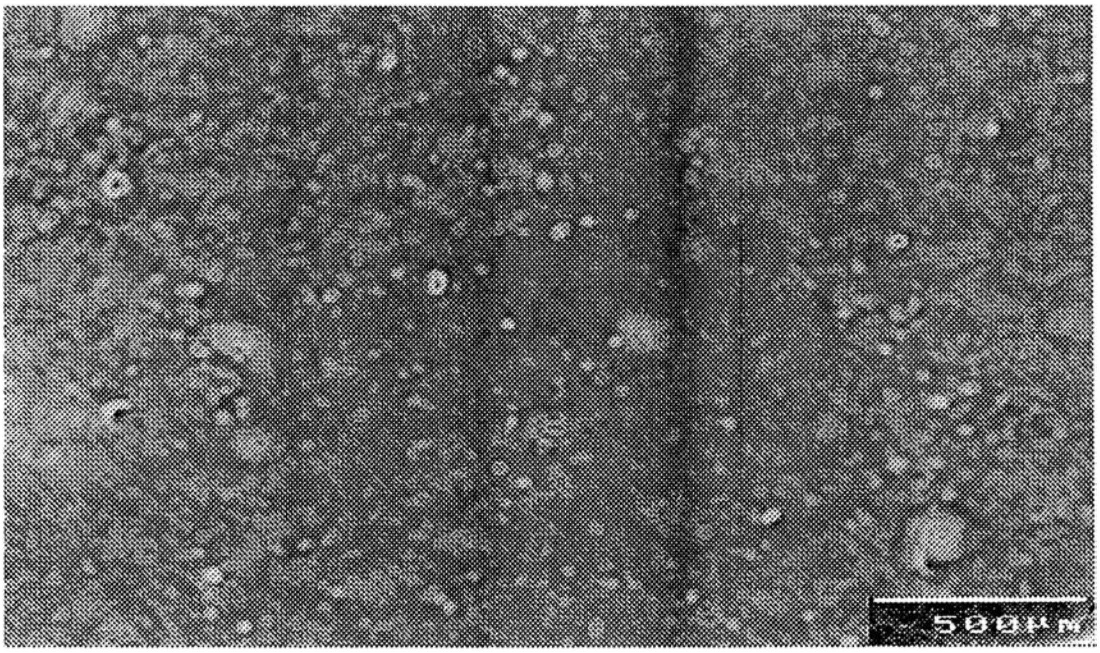

Figure H6 Optical microscope picture of natural rubber filled with PPV 4 wt%.

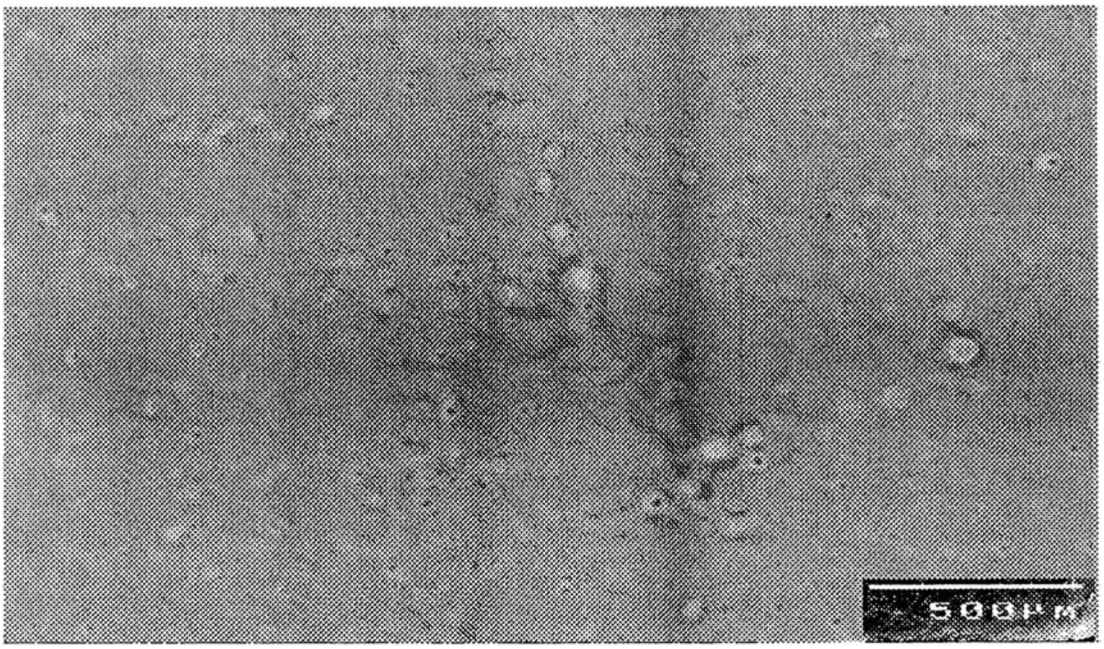

Figure H7 Optical microscope picture of natural rubber filled with OPV 0.5 wt%.

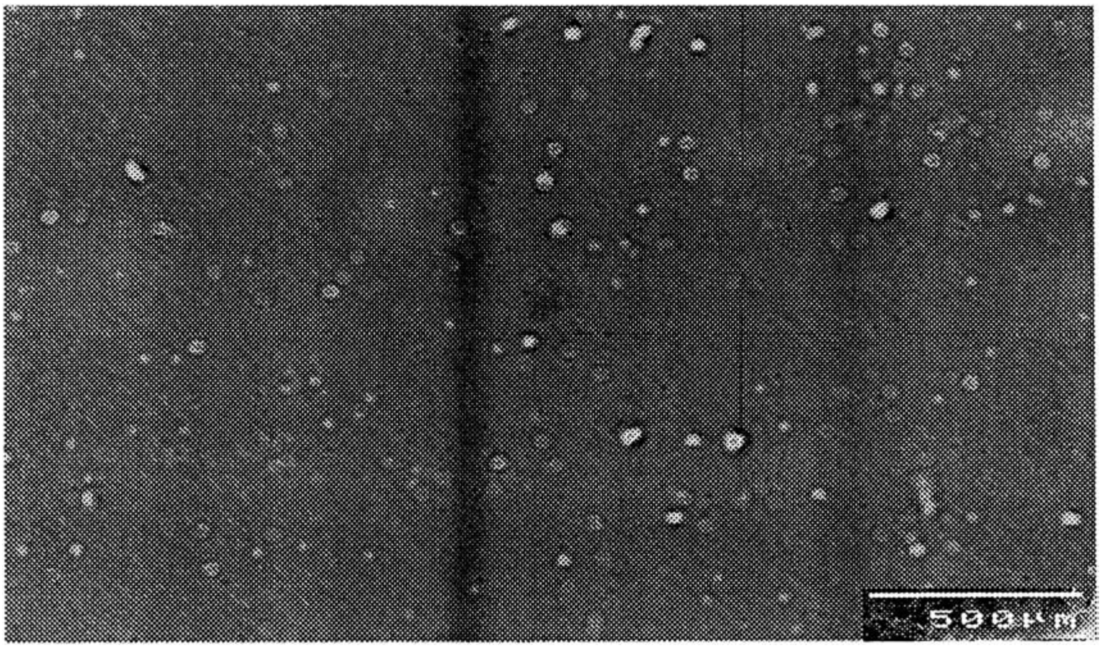

Figure H8 Optical microscope picture of natural rubber filled with OPV 1wt%.

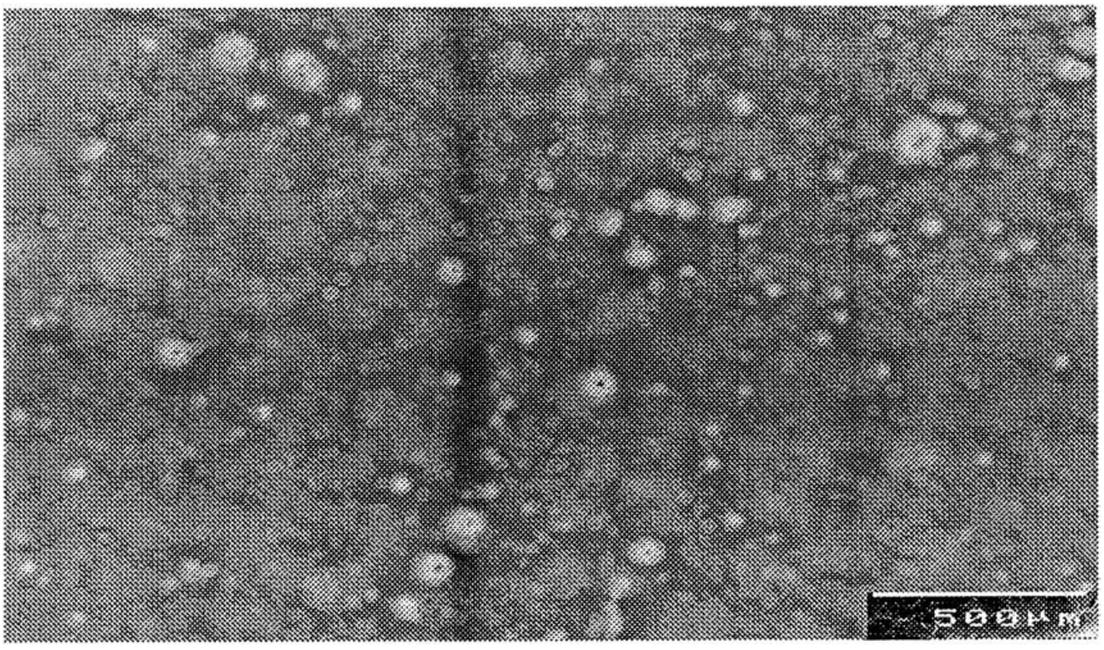

Figure H9 Optical microscope picture of natural rubber filled with OPV 2 wt%.

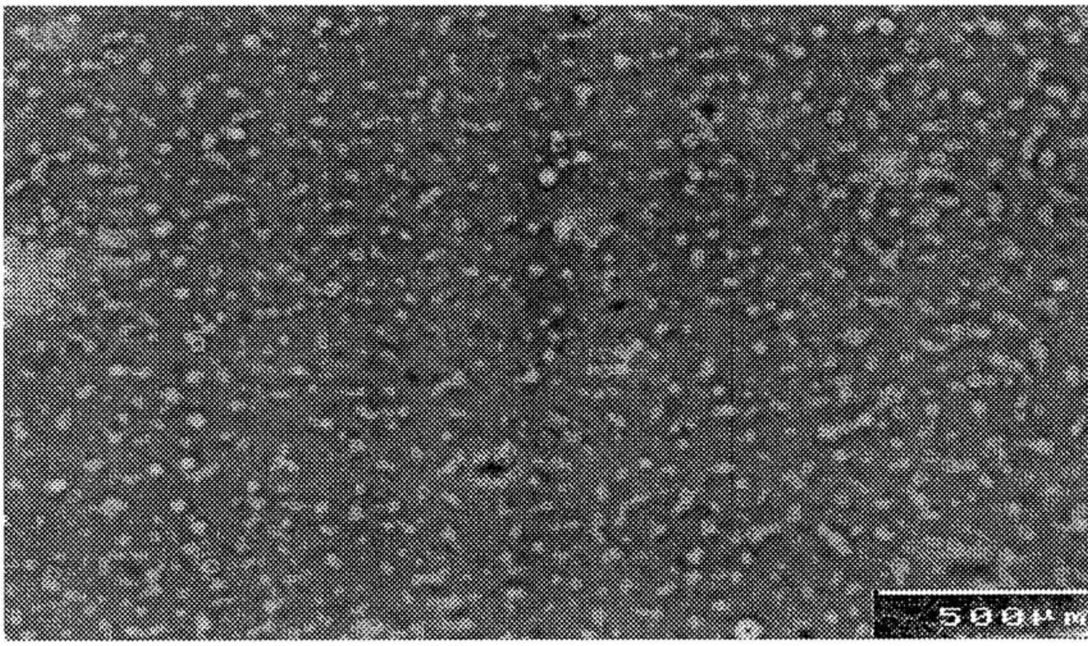

Figure H10 Optical microscope picture of natural rubber filled with OPV 3 wt%.

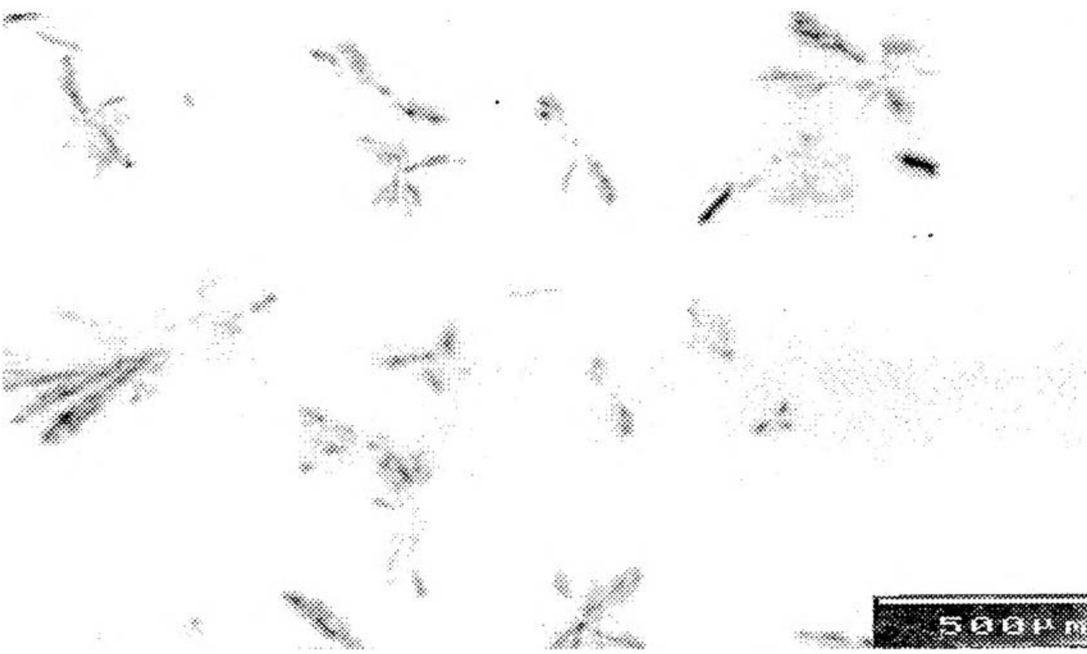

Figure H11 Optical microscope picture of natural rubber filled with OPV 4 wt%.

Appendix I SEM Micrograph of Copolymers

The scanning electron microscope was employed to investigate the fracture surface of the samples.

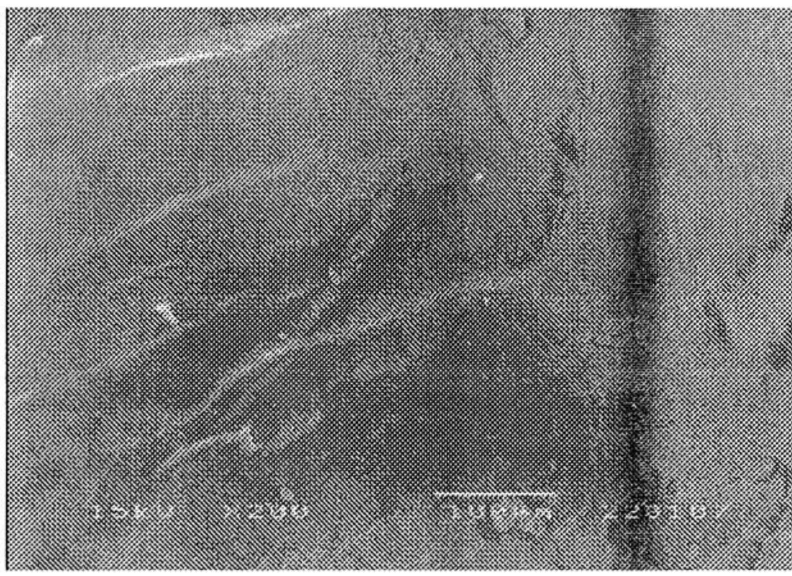

Figure I1 SEM micrograph of the tensile fracture surface of natural rubber filled with PPV 0.5 wt%.

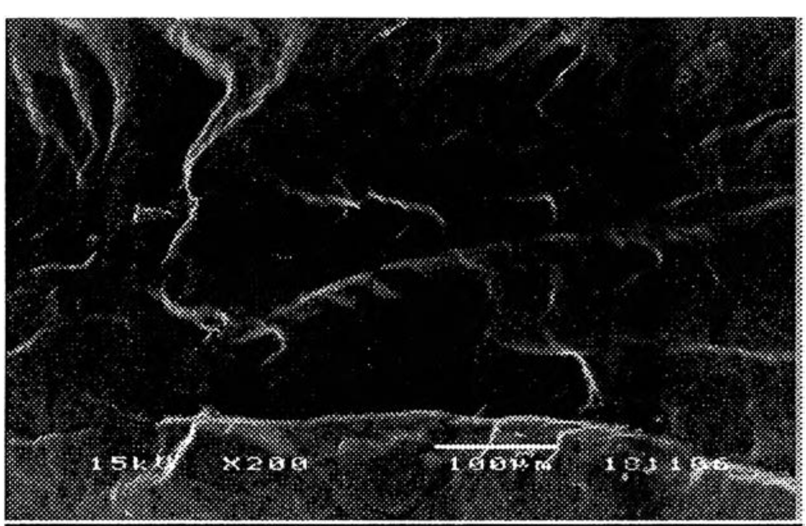

Figure I2 SEM micrograph of the tensile fracture surface of natural rubber filled with PPV 1 wt%.

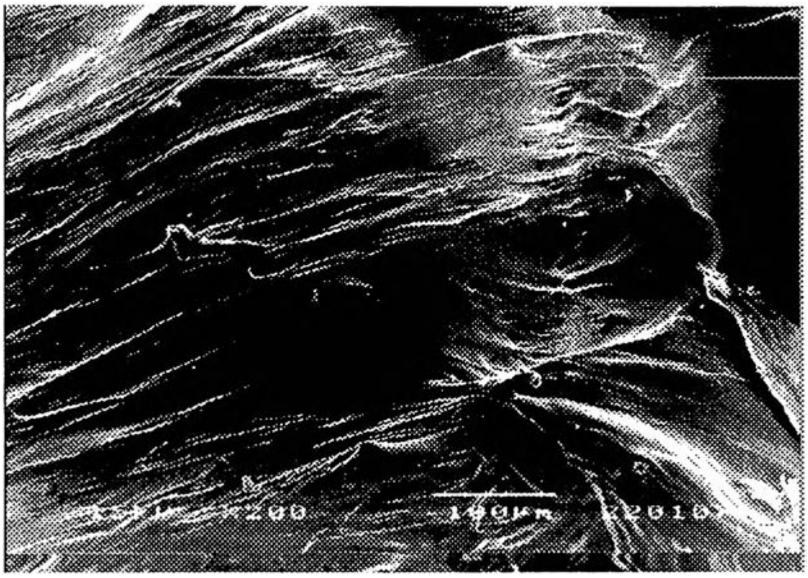

Figure I3 SEM micrograph of the tensile fracture surface of natural rubber filled with PPV 2 wt%.

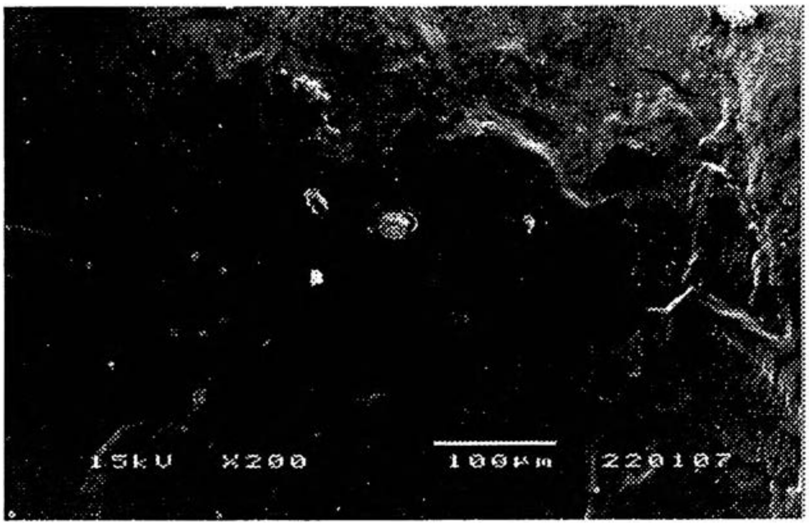

Figure I4 SEM micrograph of the tensile fracture surface of natural rubber filled with PPV 3 wt%.

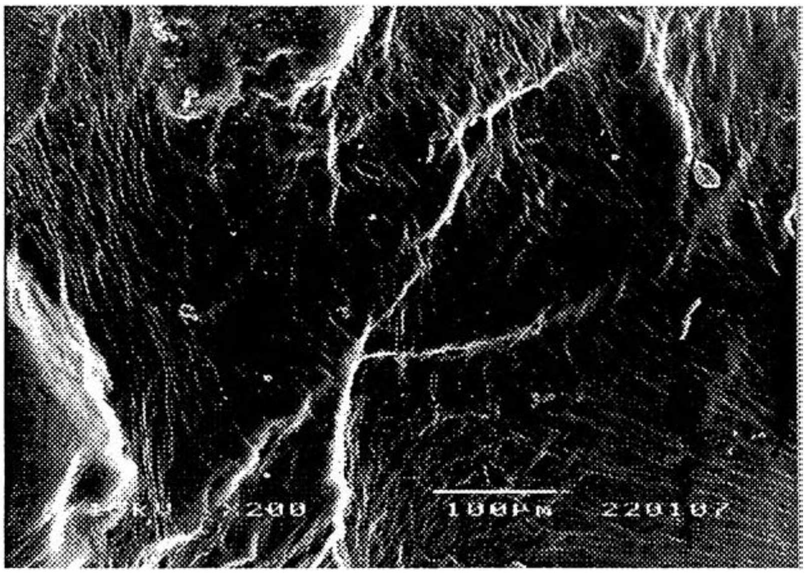

Figure I5 SEM micrograph of the tensile fracture surface of natural rubber filled with PPV 4 wt%.

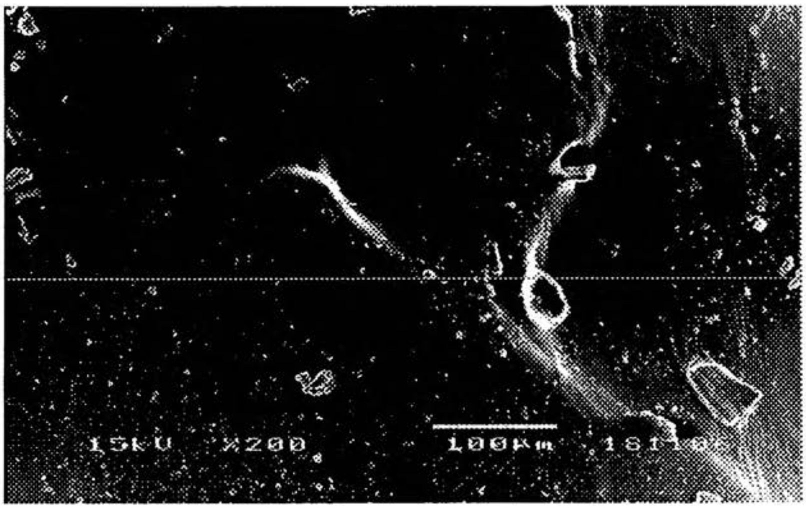

Figure I6 SEM micrograph of the tensile fracture surface of natural rubber filled with OPV 0.5 wt%.

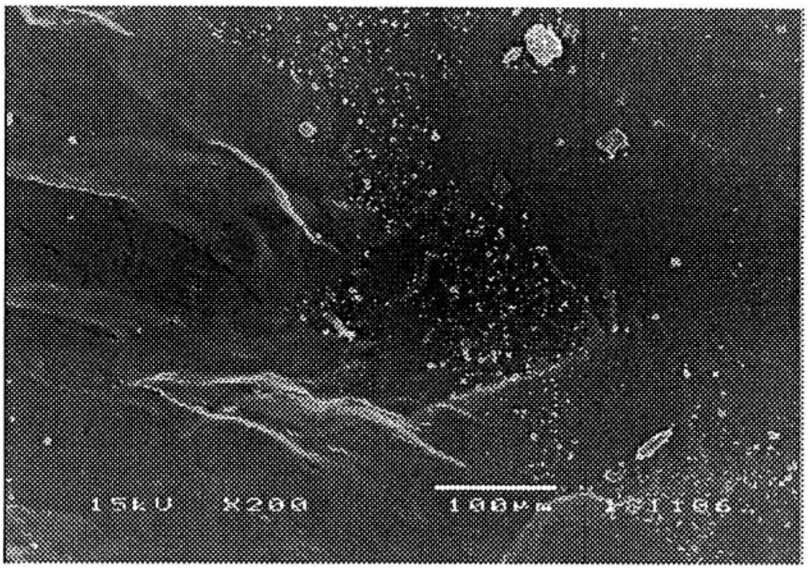

Figure I7 SEM micrograph of the tensile fracture surface of natural rubber filled with OPV 1 wt%.

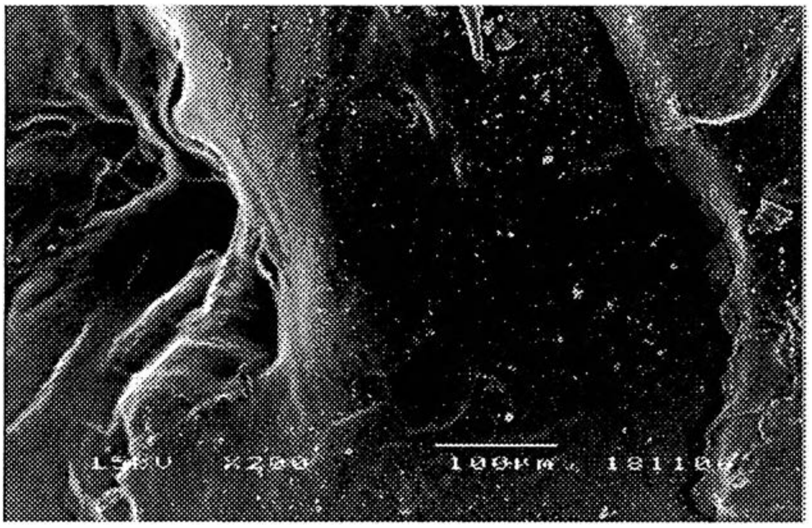

Figure I8 SEM micrograph of the tensile fracture surface of natural rubber filled with OPV 2 wt%.

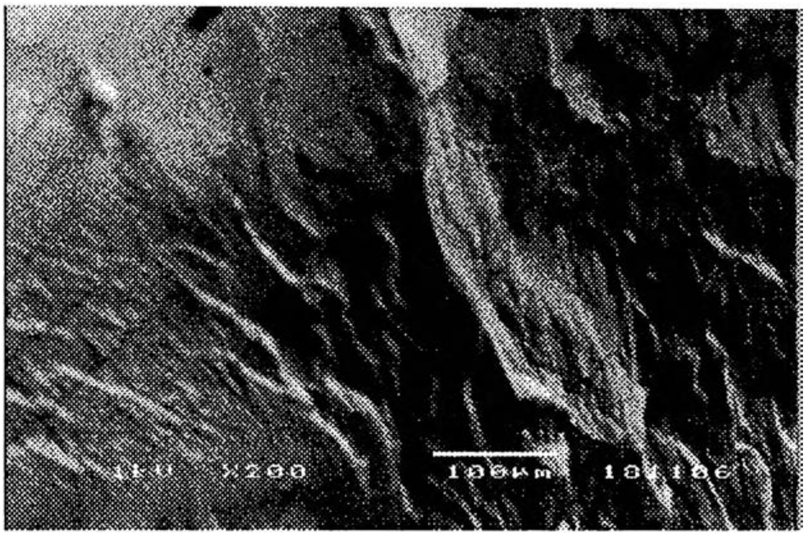

Figure I9 SEM micrograph of the tensile fracture surface of natural rubber filled with OPV wt%.

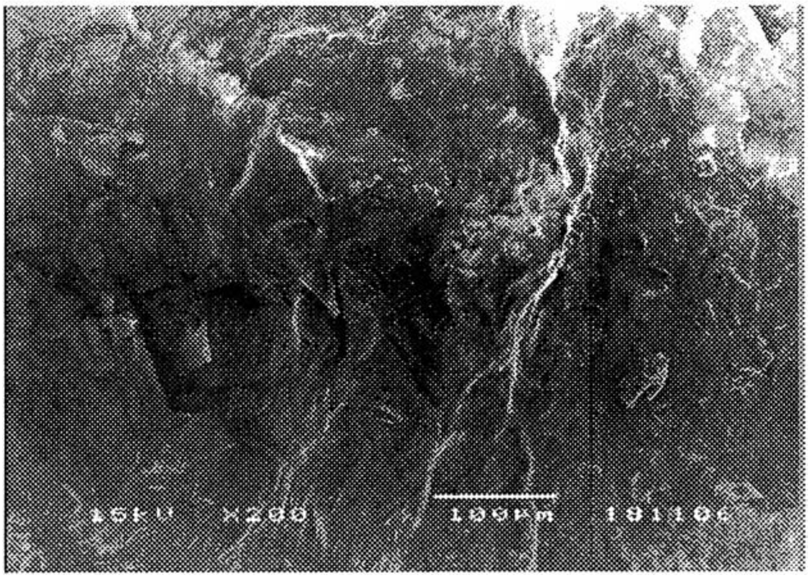

Figure I10 SEM micrograph of the tensile fracture surface of natural rubber filled with OPV 4 wt%.

CURRICUM VITAE

Name: Ms. Ketsuda Anuchai

Date of Birth: August 20, 1982

Nationality: Thai

University Education:

2000-2004 Bachelor Degree of Science, Faculty of Industrial Chemistry, Chiang Mai University, Chiang Mai, Thailand