REFERENCES

A. J. Nijienhuis, D. W. Grijpma and A. J. Pennings (1996). Polymer. 37, 2783.

A. Mousa, U.S. Ishiaku and Z.A. Mohd Ishak (2000). Rheological properties of dynamically vulcanized poly(vinyl chloride)/epoxidized natural rubber thermoplastic elastomers: effect of processing variables. Polymer Testing. 19, 193–204.

Abdou - Sabet, S., Puydak, R.C., and Rader, C.P. (1996). Dynamically vulcanized thermoplastic elastomers. Rubber Chemistry and Technology, 69, 476-494.

Ahmad Mousa, U. S. Ishiaku and Z. A. Mohd Ishak (2005). Oil Resistance of Dynamically Vulcanized Poly(Vinyl Chloride)/Nitrile Butadiene Rubber Thermoplastic Elastomers. Polymer Bulletin, 53, 203–212.

Akiba, M. and Hashim, A.S. (1997). Vulcanization and crosslinking in elastomers. Progress in polymer science, 22(3), 475-521.

Asha Elizabeth Mathai and Sabu Thomas (2005). Morphology, mechanical and viscoelastic properties of nitrile rubber/epoxidized natural rubber blends. Journal of applied polymer science, 97, 1561 – 1573.

C. Nakason, P. Wannavilai and A. Kaesaman (2006). Effect of vulcanization system on properties of thermoplastic vulcanizates based on epoxidized natural rubber/polypropylene blends. Polymer Testing, 25, 34–41.

C. S. L. Baker, I. R. Gelling and R. Newell (1985). Epoxidized Natural Rubber. Rubber Chem. Technol., 58.

Chantara Thevy Ratnam and Mohd Saiful Ahmad (2006). Stress – Strain, morphological and rheological properties of radiation – crosslinked PVC/ENR blend. Malaysian Polymer Journal, 1, 1 – 10.

Chen G. X. and Yoon J. S. (2005). Thermal stability of poly(L-lactide)/ poly(butylenes succinate)/clay nanocomposites. Polym Degrad Stab, 88(2), 206 – 212.

Chen MH, Hsu YH, Lin CP. Chen YJ, Young TH. (2005). Interactions of acinar cells on biomaterials with various surface properties. JBiomed Mater Res A., 74(2), 254-262.

Chen RS, Chen YJ, Chen MH and Young TH (2007). Cell-surface interactions of rat tooth germ cells on various biomaterials. Journal of Biomedical Materials Research. 83(1), 241-248.

Das A, Costa FR, Wagenknecht U, Heinrich G (2008). Nanocomposites based on chloroprene rubber: effect of chemical nature and organic modification of nanoclay on the vulcanizate properties. Eur Polym J, 44, 3456 – 65.

Drobny, J.G. (Ed.). (1999). Technology of Fluoropolymers. New Hampshire: CRC Press.

F. S. Liao, A. C. Su and Tzu – Chien J. Hsu (1994). Polymer, 35, 2579.

Frank M. McMillan and De Loss E. Winkler (1952). Softening agent for rubber and resultant rubber composition. Patented no. 2,*582,264.*

G.H. Yew, W.S. Chow, Z.A. Mohd Ishak and A.M. Mohd Yusof (2009). Natural Weathering of Poly (Lactic Acid): Effects of Rice Starch and Epoxidized Natural Rubber. Journal of Elastomers and Plastics, 41(4), 369-382.

H. Ismail and R. Ramli (2007). Organoclay filled natural rubber nanocomposites: The effects of filler loading and mixing method. Journal of reinforced plastics and composites, 27, 16 – 17.

H. Ismail and S. Suzaimah (2000). Styrene butadiene rubber/epoxidized natural rubber blends: dynamic properties, curing characteristics and swelling studies. Polymer Testing, 19, 879–888.

Hagen, R., Salmén, L., and Stenberg, B. (1996). Effects of the type of crosslink on viscoelastic properties of natural rubber. Journal of Polymer Science Part B: Polymer Physics, 34(12), 1997-2006.

Hana Ismail and H.M. Hairunezam (2001). The effect of a compatibilizer on curing characteristics, mechanical properties and oil resistance of styrene butadiene rubber/epoxidized natural rubber blends. European Polymer Journal, 37, 39-44.

Hanafi Ismail and H. Anuar (2000). Palm oil fatty acid as an activator in carbon black filled natural rubber compounds: dynamic properties, curing characteristics, reversion and fatigue studies. Polymer testing, 19, 349-359.

Holden, G., Kricheldorf, H.R., and Quirk, R.P. (Eds.). (2004). Thermoplastic Elastomers. Munich: Hanser Verlag, 143-146.

Hsin - Chieh Chen, Chen - Hao Tsai and Ming – Chien Yang (2011). Mechanical properties and biocompatibility of electrospun polylactide and poly(vinylidene fluoride) mats. J Polym Res, 18, 319-327.

Ishak ZAM and Baker AA (1995). An investigation on the potentials of rice husk ash as filler for epoxidized natural rubber. Eur. Polym. J., 31(3), 259 – 269.

Jiamjitsiripong K. and Pattamaprom C. (2011). Effects of Epoxidized Natural Rubber on Gas Barrier and mechanical properties of NR/BIIR composites. Journal of Elastomers and Plastics., Published online before print at <http://jep.sagepub.com/content/early/2011/03/11/0095244311400502>

Joy K. Mishra, Young-Wook Chang and Wonho Kim (2011). The effect of peroxide crosslinking on thermal, mechanical, and rheological properties of polycaprolactone/epoxidized natural rubber blends. Polym. Bull., 66, 673-681.

Jürdens, K. (2002). The pan-European strategic market study TPE 2000. TPE in der Prozesskette, VDI-Gesellschaft Kunststofftechnik, VDI-Verlag, Düsseldorf.

Kaushik Pal, R. Rajasekar, Dong Jin Kang, Zhen Xiu Zhang, Jin Kuk Kim and C.K. Das (2009). Effect of epoxidized natural rubber–organoclay nanocomposites on NR/high styrene rubber blends with fillers. Materials and Design, 30, 4035–4042.

L. E. Yahaya, K. O. Adebowale, A. R. R. Menon, S. Rugmini, B. I. Olu – Owolabi and J. Chameswary (2010). Natural rubber/organoclay nanocomposites: Effect of filler dosage on the physicomechanical properties of vulcanizates. African Journal of Pure and Applied Chemistry, 4(9), 198 – 205.

Li. Y and Shimizu H. (2007). Macromol Biosci, 7, 921.

Lyons, B. J. (1993). The effect of radiation on the physical and chemical properties of polyethylene containing and antioxidant and /or other additives. *Radiation* Physical Chemistry, 42, 197 – 205.

M.C. Senake Perera, U.S. Ishiaku and Z.A. Mohd. Ishak (2001). Characterisation of PVC/NBR and PVC/ENR50 binary blends and PVC/ENR50/NBR ternary blends by DMA and solid state NMR. European Polymer Journal, 37, 167-178.

Marega C. and Marigo A. (2003). Influence of annealing and chain defects on the melting behavior of poly(vinylidene fluoride). European Polymer Journal, 39(8), 1713-1720.

Mauro PJD, deRudder J, Etienne JP (1990). Rubber world. January.

Nelisen L. E. (1962). Mechanical properties of polymers. Van Nostrand Reinhold Company, New York.

Nor Azowa Ibrahim, Wan Md Zin Wan Yunus, Maizatulnisa Othman, Khalina Abdan and Kamarul Arifin Hadithon (2010). Poly(Lactic Acid) (PLA) - reinforced Kenaf Bast Fiber Composites: The effect of Triacetin. Journal of reinforced plastics and composites, 29, 1099.

P. Boonfaung, P. Wasutchanon and A. Somwangthanaroj (2011). Development of packaging film from bioplastic polylactic acid (PLA) with plasticizers. PACCON2011 (Pure andapplied chemistry international conference).

P. L. Teh, Z. A. Mohd Ishak, U. S. Ishiaku and J. Karger-Kocsis (2003). Jurnal Teknologi 39 (A) Keluaran Khas. Dis., 1 – 10.

Peiyo L., Li W., Guojun S., Lanlan Y., Feng Q. and Liangdong S. (2008). Characterization of high performance exfoliated natural rubber/organoclay nanocomposites. J. Appl. Polym. Sci., 109, 3831.

Phothiphon K. (2010). Functionalized natural rubber: rubber parts for gasohol resistance. A thesis submitted in partial fulfillment of the requirements for the degree of master of science, PPC, Chulalongkorn University.

R. D. Simoes, A. E. Job, D. L. Chinaglia, V. Zucolotto, J. C. Camargo – Filho, N. Alves, J. A. Giacometti, O. N. Oliveira Jr and C. J. L. Constantino (2005). Structural characterization of blends containing both PVDF and natural rubber latex. Journal of Raman spectroscopy, 36, 1118 – 1124.

R. Rajasekar, Kaushik Pal, Gert Heinrich, Amit Das and C.K. Das (2009). Development of nitrile butadiene rubber - nanoclay composites with epoxidized natural rubber as compatibilizer. Materials and design, 30, 3839 – 3845.

Ray E. Drumright, Patrick R. Gruber and David E. Henton. Polylactic Acid Technology. Advanced Materials.

Sachiko Ishida, Reiko Nagasaki, Keisuke chino, Tungalag Dong and Yoshio Inoue (2009). Toughening of poly(L-lactide) by melt blending with rubbers. Journal of applied polymer science, 113, 558 – 566.

Scharnowski D. (2005). Characterisation of the influence of cooling rates on structure and properties of dynamic vulcanizates. *Dissertation: Halle (Saale),* Martin-Luther-Universität Halle-Wittenberg, Mathematisch-Naturwissenschaftlich-Technische Fakultät, 1-134.

Sen – lin Yang, Zhi – Hua Wu, Wei Yang and Ming – Bo Yang (2008). Thermal and mechanical properties of chemical crosslinked polylactide (PLA). Polymer testing, 27, 957 – 963.

Snooppy George, N.R. Neelakantan, K.T. Varughese and Sabu Thomas (1997). Dynamic mechanical properties of isotactic polypropylene/nitrile rubber blends: effects of blend ratio, reactive compatibilization and dynamic vulcanization. Journal of polymer science: Part B: Polymer physics, 35, 2309 – 2327.

Supri and H. Ismail (2006). Effects of dynamic vulcanization and glycidyl methacrylate on properties of recycled poly(vinyl chloride)/acrylonitrile butadiene rubber blends. Polymer Testing, 25, 318-326.

Thipmanee Ranumas, Magaraphan Rathanawan and Nampitch Tarinee (2009). ResearchGate, DOI: ISBN 978-974-660362-1.

Unnikirishnan G. and Thomas S. (1997). Sorption and diffusion of aliphatic hydrocarbons into crosslinked natural rubber. Journal of Polymer Science Part B: Polymer Physics, 35(5), 725-734.

Yamoun C. and Magaraphan R. Peroxide Cured Natural Rubber/Fluoroelastomer /High Density Polyethylene via Dynamic Vulcanization. Published online in Wiley Online Library (2011) DOI 10.1002/pen.22018.

Yoksan R. (2008). Epoxidized Natural Rubber for Adhesive Applications. Kasetsart J.(Nat. Sci.), 42, 325 – 332.

Z. Mohamad, H. Ismail and R. Chantara Thevy. Tensile properties and morphology of dynamically vulcanized ENR-50/EVA blends: Different vulcanization system. Journal of chemical and natural resources engineering. 91 - 98.

Zhang G, Zhang J, Wang S and Shen D (2003). J Polym Sci Polym Phys. 41, 23.

APPENDICES

Appendix A: Calculations of Crystallinity Percentage

The calculations of crystallinity percentage were shown below including crystallinity of PVDF, PLA, PVDF in the blend of PVDF-80/PLA-20, PLA in the blend of PVDF-80/PLA-20 and PVDF in thermoplastic vulcanizates at various ENR/PVDF/PLA ratios and DBPH contents. The enthalpy of melting per gram of 100 % crystalline of PLA is 93 J/g and that of PVDF is 104.7 J/g.

From $$X_c\,(\%) = \frac{\Delta H^{*}_{sample}}{\Delta H^{0}_{ref}} \times 100$$

ΔH^{*}_{sample} is the measured enthalpy of sample. ΔH^{0}_{ref} is the enthalpy of melting per gram of 100 % crystalline of sample.

Percent Crystallinity of PVDF

From the measured result, ΔH^{*}_{PVDF} is 32.4 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$\text{Percent crystallinity of PVDF} = X_{PVDF}\,(\%) = \frac{\Delta H^{*}_{PVDF}}{\Delta H^{0}_{PVDF}} \times 100$$

$$= \frac{32.4}{104.7} \times 100$$

$$= 31\ \%$$

Percent Crystallinity of PLA

From the measured result, ΔH^{*}_{PLA} is 10.9 J/g and ΔH^{0}_{PLA} is 93 J/g.

$$\text{Percent crystallinity of PLA} = X_{PLA}\,(\%) = \frac{\Delta H^{*}_{PLA}}{\Delta H^{0}_{PLA}} \times 100$$

$$= \frac{10.9}{93} \times 100$$

$$= 12\ \%$$

In case of the thermoplastic blend, the crystallinity percentage of PVDF and PLA was calculated by relating to the composition of PVDF/PLA which was 80/20. The equations were shown below:

$$X_{Blend\ (PVDF)}\ (\%) = \frac{\Delta H^{*}_{Blend}}{(0.8 \times \Delta H^{0}_{PVDF})} \times 100$$

And

$$X_{Blend\ (PLA)}\ (\%) = \frac{\Delta H^{*}_{Blend}}{(0.2 \times \Delta H^{0}_{PLA})} \times 100$$

$X_{Blend\ (PVDF)}$ and $X_{Blend\ (PLA)}$ are the relative percent crystallinity of the PVDF and PLA in the PVDF/PLA blend. ΔH^{*}_{Blend} is the measured enthalpy. The enthalpy of melting per gram of 100 % crystalline of PLA is 93 J/g and that of PVDF is 104.7 J/g.

Relative Percent Crystallinity of PVDF in The PVDF/PLA Blend

From the measured result, $\Delta H^{*}_{Blend\ (PVDF)}$ is 39.4 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{Blend\ (PVDF)}\ (\%) = \frac{\Delta H^{*}_{Blend}}{(0.8 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{24.3}{(0.8 \times 104.7)} \times 100$$

$$= 29\ \%$$

Relative Percent Crystallinity of PLA in The PVDF/PLA Blend

PLA *peak 1*: From the measured result, $\Delta H^{*}_{Blend\ (PLA)}$ is 0.67 J/g and ΔH^{0}_{PLA} is 93 J/g.

$$X_{Blend\ (PLA)}\ (\%) = \frac{\Delta H^{*}_{Blend}}{(0.2 \times \Delta H^{0}_{PLA})} \times 100$$

$$= \frac{0.67}{(0.2 \times 93)} \times 100$$

$$= 3.6\ \%$$

PLA *peak 2*: From the measured result, $\Delta H^{*}_{Blend\ (PLA)}$ is 0.27 J/g and ΔH^{0}_{PLA} is 93 J/g.

$$X_{Blend\ (PLA)}\ (\%) = \frac{\Delta H^{*}_{Blend}}{(0.2 \times \Delta H^{0}_{PLA})} \times 100$$

$$X_{Blend\,(PLA)}(\%) = \frac{0.27}{(0.2 \times 93)} \times 100$$

$$= 1.4\ \%$$

For thermoplastic vulcanizates (TPV), the only crystallization of PVDF was occurred. The relative percent crystallization was calculated to the composition of PVDF in TPV blend. The equations were shown below:

The ENR/PVDF/PLA ratio of 50/40/10;

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.4 \times \Delta H^{0}_{PVDF})} \times 100$$

The ENR/PVDF/PLA ratio of 50/50/0;

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.5 \times \Delta H^{0}_{PVDF})} \times 100$$

The ENR/PVDF/PLA ratio of 70/20/10;

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.2 \times \Delta H^{0}_{PVDF})} \times 100$$

The ENR/PVDF/PLA ratio of 70/30/0;

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.3 \times \Delta H^{0}_{PVDF})} \times 100$$

$X_{TPV\,(PVDF)}$ is the relative percent crystallinity of the PVDF in the TPV blend. ΔH^{*}_{TPV} is the measured enthalpy. The enthalpy of melting per gram of 100 % crystalline of PVDF is 104.7 J/g.

Relative Percent Crystallinity of PVDF in The TPV Blend

❖ The ENR/PVDF/PLA Ratio of 50/40/10 at DBPH 0 phr (Ternary blend);

From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 13.4 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.4 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{13.4}{(0.4 \times 104.7)} \times 100$$

$$= 32\ \%$$

- The ENR/PVDF/PLA Ratio of 50/40/10 at DBPH 3 phr;

  From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 10.7 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.4 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{10.7}{(0.4 \times 104.7)} \times 100$$

$$= 25.5\ \%$$

- The ENR/PVDF/PLA Ratio of 50/40/10 at DBPH 7 phr;

  From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 6.0 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.4 \times \Delta H^{0}_{PVDF})} \times 100$$

$$\frac{6.0}{(0.4 \times 104.7)} \times 100 \qquad =$$

$$= 14.4\ \%$$

- The ENR/PVDF/PLA Ratio of 50/50/0 at DBPH 3 phr;

  From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 15.5 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.5 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{15.5}{(0.5 \times 104.7)} \times 100$$

$$= 29.6\ \%$$

- The ENR/PVDF/PLA Ratio of 50/50/0 at DBPH 7 phr;

  From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 12.9 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}(\%) = \frac{\Delta H^{*}_{TPV}}{(0.5 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{12.9}{(0.5 \times 104.7)} \times 100$$

$$= 24.7\ \%$$

- The ENR/PVDF/PLA Ratio of 70/20/10 at DBPH 3 phr;

From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 5.2 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}\,(\%) = \frac{\Delta H^{*}_{TPV}}{(0.2 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{5.2}{(0.2 \times 104.7)} \times 100$$

$$= 24.6\ \%$$

- The ENR/PVDF/PLA Ratio of 70/30/0 at DBPH 3 phr;

From the measured result, $\Delta H^{*}_{TPV\,(PVDF)}$ is 7.6 J/g and ΔH^{0}_{PVDF} is 104.7 J/g.

$$X_{TPV\,(PVDF)}\,(\%) = \frac{\Delta H^{*}_{TPV}}{(0.3 \times \Delta H^{0}_{PVDF})} \times 100$$

$$= \frac{7.6}{(0.3 \times 104.7)} \times 100$$

$$= 24\ \%$$

Appendix B: Oil Swelling Index

Data of oil swelling index before aging in chapter IV were shown in Tables B1 – B4 and data of oil swelling index after aging were shown in Tables B5 – B8. The results included immersion at room temperature and 100 °C for both of 24 hours and 7 days.

Table B1 The swelling index at room temperature for 24 hours before aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	3.02	2.86	2.75	1.29
	5	2.66	2.55	2.35	1.26
	7	2.19	2.08	2.00	1.27
50/40/10	0	2.05	2.40	1.75	1.17
	3	1.43	1.41	1.38	1.12
	5	1.33	1.37	1.34	1.11
	7	1.33	1.32	1.26	1.08
60/30/10	0	2.46	2.49	2.15	1.23
	3	1.64	1.59	1.41	1.17
70/20/10	0	4.20	4.04	2.90	1.30
	3	1.70	1.81	1.84	1.22
50/50/0	3	1.35	1.35	1.49	1.10
	5	1.27	1.28	1.25	1.07
	7	1.28	1.28	1.28	1.06
60/40/0	3	1.49	1.48	1.45	1.13
70/30/0	3	1.65	1.67	1.63	1.19

Table B2 The swelling index at room temperature for 7 days before aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	3.10	3.03	2.93	1.32
	5	2.72	2.64	2.50	1.29
	7	2.29	2.26	2.21	1.28
50/40/10	0	2.52	2.56	2.41	1.19
	3	1.48	1.47	1.44	1.12
	5	1.43	1.41	1.36	1.12
	7	1.35	1.36	1.33	1.13
60/30/10	0	2.60	2.66	2.43	1.22
	3	1.66	1.70	1.59	1.18
70/20/10	0	5.28	4.60	4.26	1.31
	3	1.93	1.90	1.80	1.21
50/50/0	3	1.40	1.39	1.37	1.13
	5	1.31	1.30	1.29	1.12
	7	1.29	1.32	1.30	1.12
60/40/0	3	1.51	1.53	1.47	1.18
70/30/0	3	1.68	1.68	1.66	1.21

Table B3 The swelling index at room temperature for 24 hours after aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	3.16	3.02	2.71	1.28
	5	2.68	2.56	2.35	1.29
	7	2.31	2.23	2.11	1.27
50/40/10	0	2.70	2.43	2.16	1.22
	3	1.46	1.48	1.42	1.10
	5	1.44	1.41	1.39	1.10
	7	1.34	1.34	1.33	1.08
60/30/10	0	2.89	2.44	2.16	1.28
	3	1.68	1.67	1.61	1.18
70/20/10	0	4.97	4.73	3.20	1.32
	3	1.92	1.96	1.83	1.21
50/50/0	3	1.37	1.38	1.35	1.07
	5	1.26	1.24	1.22	1.04
	7	1.27	1.28	1.27	1.06
60/40/0	3	1.48	1.49	1.45	1.13
70/30/0	3	1.68	1.68	1.63	1.19

Table B4 The swelling index at room temperature for 7 days after aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	3.20	3.16	3.00	1.33
	5	2.69	2.60	2.51	1.30
	7	2.36	2.31	2.24	1.30
50/40/10	0	2.91	2.81	2.44	1.25
	3	1.46	1.47	1.42	1.13
	5	1.45	1.42	1.40	1.14
	7	1.34	1.34	1.33	1.08
60/30/10	0	3.08	2.92	2.47	1.31
	3	1.68	1.67	1.61	1.18
70/20/10	0	5.41	5.20	4.53	1.33
	3	1.92	1.96	1.83	1.21
50/50/0	3	1.38	1.39	1.36	1.12
	5	1.31	1.29	1.27	1.10
	7	1.30	1.30	1.29	1.12
60/40/0	3	1.51	1.52	1.45	1.17
70/30/0	3	1.71	1.71	1.65	1.21

Table B5 The swelling index at 100 °C for 24 hours before aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	2.84	2.78	2.82	1.55
	5	2.57	2.50	2.44	1.50
	7	2.12	2.02	1.92	1.40
50/40/10	0	-	-	-	-
	3	1.60	1.50	1.69	1.23
	5	1.50	1.47	1.47	1.21
	7	1.43	1.41	1.39	1.21
60/30/10	0	-	-	-	-
	3	1.90	1.84	1.81	1.25
70/20/10	0	-	-	-	-
	3	2.22	2.18	2.46	1.26
50/50/0	3	1.53	1.47	1.64	1.30
	5	1.44	1.37	1.38	1.24
	7	1.41	1.38	1.34	1.24
60/40/0	3	1.71	1.68	1.65	1.35
70/30/0	3	1.98	1.86	1.96	1.33

Table B6 The swelling index at 100 °C for 7 days before aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	2.84	2.89	2.86	1.55
	5	2.58	2.55	2.50	1.51
	7	2.12	2.08	1.96	1.39
50/40/10	0	-	-	-	-
	3	1.63	1.55	1.73	1.37
	5	1.53	1.52	1.53	1.21
	7	1.42	1.39	1.39	1.19
60/30/10	0	-	-	-	-
	3	1.90	1.92	1.87	1.26
70/20/10	0	-	-	-	-
	3	2.43	2.31	2.48	1.33
50/50/0	3	1.57	1.54	1.68	1.46
	5	1.47	1.41	1.42	1.24
	7	1.41	1.39	1.34	1.23
60/40/0	3	1.73	1.87	1.68	1.34
70/30/0	3	2.13	1.97	1.97	1.41

Table B7 The swelling index at 100 °C for 24 hours after aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	2.90	2.81	2.87	1.56
	5	2.56	2.48	2.53	1.53
	7	2.10	2.03	2.01	1.45
50/40/10	0	-	-	-	-
	3	1.54	1.58	1.71	1.30
	5	1.45	1.52	1.42	1.19
	7	1.41	1.42	1.38	1.16
60/30/10	0	-	-	-	-
	3	1.97	1.89	1.85	1.25
70/20/10	0	-	-	-	-
	3	2.48	2.40	2.47	1.32
50/50/0	3	1.50	1.47	1.65	1.29
	5	1.41	1.39	1.34	1.20
	7	1.37	1.40	1.36	1.18
60/40/0	3	1.73	1.70	1.59	1.25
70/30/0	3	1.96	1.95	2.00	1.34

Table B8 The swelling index at 100 °C for 7 days after aging

ENR/PVDF/PLA, % wt	DBPH, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
100/0/0	3	2.89	2.87	2.87	1.56
	5	2.52	2.51	2.55	1.54
	7	2.11	2.08	2.02	1.45
50/40/10	0	-	-	-	-
	3	1.62	1.61	1.75	1.45
	5	1.49	1.55	1.51	1.18
	7	1.40	1.43	1.36	1.15
60/30/10	0	-	-	-	-
	3	1.95	1.95	1.87	1.23
70/20/10	0	-	-	-	-
	3	2.72	2.63	2.47	1.39
50/50/0	3	1.53	1.52	1.68	1.52
	5	1.43	1.42	1.41	1.20
	7	1.37	1.42	1.37	1.19
60/40/0	3	1.73	1.76	1.62	1.26
70/30/0	3	2.13	2.05	2.01	1.42

Data of oil swelling index before aging in chapter V were shown in Tables B9 – B12 and data of oil swelling index after aging were shown in Tables B13 – B16. The results included immersion at room temperature and 100 °C for both of 24 hours and 7 days.

Table B9 The swelling index of organoclay-filled TPV at room temperature for 24 hours before aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.33	1.37	1.34	1.11
	3	1.37	1.36	1.34	1.07
	5	1.37	1.36	1.33	1.08
	7	1.34	1.34	1.31	1.08
	10	1.35	1.33	1.31	1.07
50/50/0	0	1.27	1.28	1.25	1.07
	3	1.30	1.28	1.30	1.04
	5	1.32	1.32	1.31	1.09
	7	1.31	1.31	1.28	1.10
	10	1.35	1.34	1.31	1.11

Table B10 The swelling index of organoclay-filled TPV at room temperature for 7 days before aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.43	1.41	1.36	1.12
	3	1.37	1.36	1.35	1.10
	5	1.37	1.37	1.33	1.11
	7	1.35	1.34	1.32	1.11
	10	1.35	1.34	1.31	1.11
50/50/0	0	1.31	1.30	1.29	1.12
	3	1.31	1.30	1.31	1.08
	5	1.33	1.34	1.33	1.14
	7	1.33	1.32	1.29	1.12
	10	1.36	1.36	1.31	1.12

Table B11 The swelling index of organoclay-filled TPV at room temperature for 24 hours after aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.44	1.41	1.39	1.10
	3	1.38	1.36	1.33	1.06
	5	1.37	1.38	1.34	1.08
	7	1.38	1.37	1.33	1.07
	10	1.35	1.35	1.34	1.06
50/50/0	0	1.26	1.24	1.22	1.04
	3	1.33	1.31	1.31	1.08
	5	1.31	1.32	1.29	1.09
	7	1.31	1.33	1.28	1.08
	10	1.36	1.35	1.32	1.11

Table B12 The swelling index of organoclay-filled TPV at room temperature for 7 days after aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.45	1.42	1.40	1.14
	3	1.38	1.37	1.34	1.11
	5	1.39	1.37	1.35	1.10
	7	1.39	1.37	1.35	1.11
	10	1.37	1.36	1.35	1.10
50/50/0	0	1.31	1.29	1.27	1.10
	3	1.34	1.34	1.34	1.13
	5	1.32	1.33	1.30	1.13
	7	1.33	1.34	1.29	1.12
	10	1.37	1.36	1.33	1.13

Table B13 The swelling index of organoclay-filled TPV at 100 °C for 24 hours before aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.50	1.47	1.47	1.21
	3	1.46	1.47	1.43	1.18
	5	1.47	1.47	1.44	1.16
	7	1.50	1.47	1.39	1.18
	10	1.46	1.47	1.41	1.18
50/50/0	0	1.44	1.37	1.38	1.24
	3	1.43	1.41	1.51	1.19
	5	1.45	1.44	1.51	1.19
	7	1.42	1.43	1.49	1.19
	10	1.42	1.45	1.50	1.19

Table B14 The swelling index of organoclay-filled TPV at 100 °C for 7 days before aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.53	1.52	1.53	1.21
	3	1.47	1.51	1.52	1.17
	5	1.48	1.51	1.43	1.16
	7	1.48	1.50	1.41	1.16
	10	1.50	1.50	1.51	1.21
50/50/0	0	1.47	1.41	1.42	1.24
	3	1.44	1.42	1.54	1.20
	5	1.46	1.45	1.55	1.21
	7	1.43	1.44	1.53	1.19
	10	1.43	1.46	1.55	1.20

Table B15 The swelling index of organoclay-filled TPV at 100 °C for 24 hours after aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.45	1.52	1.42	1.19
	3	1.45	1.47	1.42	1.18
	5	1.48	1.47	1.42	1.17
	7	1.48	1.47	1.41	1.18
	10	1.49	1.45	1.42	1.18
50/50/0	0	1.41	1.39	1.34	1.20
	3	1.42	1.46	1.51	1.19
	5	1.44	1.43	1.52	1.20
	7	1.40	1.39	1.49	1.18
	10	1.44	1.44	1.53	1.20

Table B16 The swelling index of organoclay-filled TPV at 100 °C for 7 days after aging

ENR/PVDF/ PLA, % wt	Organoclay, phr	Swelling index			
		Gasohol 91	Gasohol 95	E20	E85
50/40/10	0	1.49	1.55	1.51	1.18
	3	1.48	1.51	1.49	1.16
	5	1.48	1.51	1.43	1.17
	7	1.51	1.51	1.44	1.16
	10	1.51	1.50	1.51	1.21
50/50/0	0	1.43	1.42	1.41	1.20
	3	1.43	1.47	1.54	1.20
	5	1.45	1.44	1.55	1.21
	7	1.40	1.41	1.53	1.19
	10	1.43	1.46	1.55	1.20

Data of oil swelling index before and after aging in chapter VI were shown in Tables B17 – B20. The results included immersion at room temperature and 100 °C for both of 24 hours and 7 days.

Table B17 The swelling index of TPV both of NBR and ENR system at room temperature for 24 hours

NBR/PVDF/ PLA, % wt	Aging		Swelling index			
	Before	**After**	**Gasohol 91**	**Gasohol 95**	**E20**	**E85**
50/40/10	✓		1.17	1.15	1.15	1.06
		✓	1.15	1.15	1.14	1.06
50/50/0	✓		1.20	1.17	1.15	1.06
		✓	1.19	1.16	1.15	1.05
ENR/PVDF/ PLA, % wt	**Aging**		**Swelling index**			
	Before	**After**	**Gasohol 91**	**Gasohol 95**	**E20**	**E85**
50/40/10	✓		1.33	1.37	1.34	1.11
		✓	1.44	1.41	1.39	1.10
50/50/0	✓		1.27	1.28	1.25	1.07
		✓	1.26	1.24	1.22	1.04

Table B18 The swelling index of TPV both of NBR and ENR system at room temperature for 7 days

NBR/PVDF/ PLA, % wt	Aging		Swelling index			
	Before	After	Gasohol 91	Gasohol 95	E20	E85
50/40/10	✓		1.23	1.22	1.22	1.11
		✓	1.22	1.21	1.20	1.12
50/50/0	✓		1.24	1.22	1.22	1.11
		✓	1.24	1.22	1.21	1.11
ENR/PVDF/ PLA, % wt	**Aging**		**Swelling index**			
	Before	**After**	**Gasohol 91**	**Gasohol 95**	**E20**	**E85**
50/40/10	✓		1.43	1.41	1.36	1.12
		✓	1.45	1.42	1.40	1.14
50/50/0	✓		1.31	1.30	1.29	1.12
		✓	1.31	1.29	1.27	1.10

Table B19 The swelling index of TPV both of NBR and ENR system at 100 °C for 24 hours

NBR/PVDF/ PLA, % wt	Aging		Swelling index			
	Before	After	Gasohol 91	Gasohol 95	E20	E85
50/40/10	✓		1.25	1.22	1.34	1.24
		✓	1.23	1.21	1.35	1.25
50/50/0	✓		1.28	1.27	1.28	1.24
		✓	1.27	1.25	1.28	1.22
ENR/PVDF/ PLA, % wt	**Aging**		**Swelling index**			
	Before	**After**	**Gasohol 91**	**Gasohol 95**	**E20**	**E85**
50/40/10	✓		1.50	1.47	1.47	1.21
		✓	1.45	1.52	1.42	1.19
50/50/0	✓		1.44	1.37	1.38	1.24
		✓	1.41	1.39	1.34	1.20

Table B20 The swelling index of TPV both of NBR and ENR system at 100 °C for 7 days

NBR/PVDF/ PLA, % wt	Aging		Swelling index			
	Before	After	Gasohol 91	Gasohol 95	E20	E85
50/40/10	✓		1.23	1.22	1.34	1.35
		✓	1.21	1.21	1.33	1.35
50/50/0	✓		1.28	1.27	1.31	1.25
		✓	1.27	1.26	1.30	1.23
ENR/PVDF/ PLA, % wt	**Aging**		**Swelling index**			
	Before	**After**	**Gasohol 91**	**Gasohol 95**	**E20**	**E85**
50/40/10	✓		1.53	1.52	1.53	1.21
		✓	1.49	1.55	1.51	1.18
50/50/0	✓		1.47	1.41	1.42	1.24
		✓	1.43	1.42	1.41	1.20

CURRICULUM VITAE

Name: Ms. Tharinee Thamronglerdrit

Date of Birth: December 30, 1987

Nationality: Thai

University Education:

2006-2010 Bachelor Degree in Materials Science, Faculty of Science, Chulalongkorn University, Bangkok, Thailand

Proceedings:

1. Thamronglerdrit T., and Magaraphan R. (2012, April 24) Dynamic vulcanization of epoxidized natural rubber and fluoroplastic. Proceedings of the 3rd research symposium on Petrochemical and Materials Technology and the 18th PPC symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentation:

1. Thamronglerdrit T., and Magaraphan R. (2012, April 24) Dynamic vulcanization of epoxidized natural rubber and fluoroplastic. Paper presented at the 3rd research symposium on Petrochemical and Materials Technology and the 18th PPC symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.