REFERENCES

1. Eun, K.J., Dong, J.A., Jong, M.K. The Flurescent Polydiacetylene Liposome. J. Bull Korean Chem. Soc. 24 (2003): 5.
2. Bloor, D. Polydiacetylenes: synthesis, structure, and electronic properties (NATO ASI Series) Kluwer Academic Publishers USA, (1985).
3. Tieke, B. Polymerization of diacetylenes in multilayers J. Polym. Sco. A. 17 (1979): 1631-1644.
4. Olmsted, J. Fluorescence of polymerized diacetylene bilayer films J. Phys. Chem. 87 (1983): 4790-4792.
5. Carpick, R. First observation of mechanochromism at the nanometer scale. Langmuir 16 (2000): 1270-1278.
6. Chance, R.R., Baughman, R.H. Muller, H., Eckhardt, C.J. Thermochromism in a polydiacetyene crystal J. Chem. Phys. 67 (1977): 3616-3618.
7. Wenzêl, M. Chromatic properties of polydiacetylene films J. Am. Chem. Soc. 111 (1989): 6123-6127.
8. Beckham, G. On the origin of thermochromism in cross-polymerized diacetylene-functionalized polyamides. Macromolecules 26 (1993): 5198-5201.
9. Lio, A. Molecular imaging of thermochromic carbohydrate-modified polydiacetylene thin films. Langmuir 13 (1997): 6524-6532.
10. Lee, D.C. Structural aspects of thermochromic transition in urethane substituted polydiacetylene. Macromolecules 35 (2002): 4347-4355.
11. Muller, H., Eckhardt, C.J. Stress induced change of electronic structure in a polydiacetylene crystal. Mol. Cryst. Liq. Cryst. 45 (1978): 313-318.
12. Tomioka, Y., Tanaka, N., Imazeki, S. Surface-pressure-induced reversible color change of a polydiacetylene monolayer at a gas-water interface J. Chem. Phys. 91 (1989): 5694-5700.
13. Nallicheri, R.A. Investigations of the mechanochromic behavior of poly(urethane-diacetylene) segmented copolymers. Macromolecules 24 (1991): 517-525.
14. Mowery, M.D. Fabrication of monolayers containing internal molecular scaffolding: Effect of substrate preparation. Langmuir 14 (1998): 5594-5602.

15. Jonas, U. Reversible color switching and unusual solution polymerization of hydrazide-modified diacetylene lipids J. Am. Chem. Soc. 121 (1999): 4580-4588.

16. Charych, D.H. Direct colorimetric detection of a receptor-ligand interaction by a polymerized bilayer assembly. Science 261 (1993): 585-588.

17. Reichert, A. Polydiacetylene liposomes functionalized with sialic acid bind and colorimetrically detect influenza virus J. Am. Chem. Soc. 117 (1995): 829-830.

18. Charych, D.H. A limus test for molecular recognition using artifical membranes. Chem. Biol. 3 (1996): 113-120.

19. Ribi, H.O. Ingestibles possessing intrinsic color change US Patent 6, 866, 863 B2, 2005.

20. Hays, D.S. Diacetylenic materials for sensing applications US Patent Application 20, 050, 101, 794 Al, 2005.

21. Charych, D.H. Nucleic acid-coupled colorimetric analyte detectors US Patent 6, 306, 598, 2001.

22. Jo, Y. Colorimetric sensor employing polydiacetylene membrane US Patent 6, 277, 652, 2001.

23. Hankin, S. Spectroscopic studies of polydiacetylene: Raman evidence for surface phases on single crystals. Synth. Met. 49 (1992): 281-291.

24. Kim, W.H. A novel, soluble poly(diacetylene) containing an aromatic substituent. Macromolecules 27 (1994): 1819-1824.

25. Sukwattanasinitt, M. New processable, functionalizable polydiacetylenes, Macromolecules 32 (1999): 7361-7369.

26. Spevak, W. Molecular assemblies of functionalized polydiacetylenes. Adv. Mater 7 (1995): 7 85-89.

27. Sasaki, D.Y. High molecular orientation in mono-and trilayer polydiacetylene films imaged by atomic force microscopy J. Colloid Interface Sco. 299 (2000): 490-496.

28. Hub, H.H. Polymerizable phospholipids analogues-new stable biomembrane and cell models. Angew. Chem. Int. Engl. 19 (1980): 938-940.

29. Akimoto, A. Polymer model membrane. Angew. Chem. Int. Ed. Engl.

31. Feng, J.M., Geurts, M., Lammers, A.L. The effect of bimodeality of the particle size distribution on film formation of lattices J. Col. Int. Sco. 108 (1996): 295-303.

32. Bloor, D., Chance, R.R., Polydiacetylenes Synthesis, structure, and electronic properties. (1985).

33. Spevak, W., Nagy, J.O., Charych, D.H. Adv. Mater 7 (1985).

34. Sasaki, D.Y., Carpick, R.W., Burns, A.R. J. Col. Int. Sco. 229 (2000).

35. Mowery, M.D., Menzel, H.M., Cai, C.E., Evans, Langmuir 14 (1998).

36. Erbil, H.Y. Vinyl acetate emulsion polymerization and copolymerization with acrylic monomers. CRC Press New York: (n.p.) 6 (2000).

37. Gilbert, R.G. Emulsion polymerization. Academic Press (1995): 1-72, 292-339.

38. Gardon, J.L. Part A-1 J. Polym. Sco. 11 (1968): 623-687.

39. Pochlcin, G.W. Emulsion polymerization. Encyclopedia of polymer science and Engineering New York: (n.p.) (1986).

40. Gilbert, R.G. Emulsion polymerization. Academic Press (1995) 11.

41. Duck, E.W. Emulsion polymerization. Encyclopedia of polymer Science and technology New York: (n.p.) 5 (1966).

42. Wu, S., Soucek, M.D. Cross linking of acrylic latex coatings with cycloaliphatic diepoxide J. Polym. Sco. 41 (2000): 2017-2028.

43. Tigli, R.S., Evren, V. Synthesis and characterization of pure poly (acrylate) latexes. J. Pro. Org. Coat. 52 (2005): 144-150.

44. Lio, A., Reichert, A., Ahn, D.J., Nagy, J.O. Molecular imaging of thermochromic carbohydrate-modified polydiacetylene thin film J. Am. Chem. Soc. 13(1997):6524-6532.

45. Tachibana, T., Hosaka, N., Tokura, Y. Effect of alkyl chain length on thermochromic phase transition in urethane-subtituted polydiacetylene crystals J. Sci. Dirc. 42 (2001): 8311-8314.

46. Carpick, R.W., Sasaki, D.Y., Burns, A.R. Nanometer-scale structural, Tribological, and optical properties of ultrathin polydiacetylene film J. Eng. Phys. 41 (2000).

47. Carpick, R.W., Sasaki, D.Y., Marcus, M.S., Erikson, M.A., Burns, A.R. Polydiacetylene films J. Phys. Condens. Matt. 16 (2004): 679-697.

48. Su, Y.L., Li, J.R., Jiang, L., Coa, J. Biosensor signal amplification of vesicles

47. Carpick, R.W., Sasaki, D.Y., Marcus, M.S., Erikson, M.A., Burns, A.R. Polydiacetylene films J. Phys. Condens. Matt. 16 (2004): 679-697.

48. Su, Y.L., Li, J.R., Jiang, L., Coa, J. Biosensor signal amplification of vesicles functionalized with glycolipid for colorimetric detection of *Escherichia coli* J. Col. Int. Sco. 284 (2005): 114-119.

49. Ribi, H.O. Ingestible processing intrinsic color change US Patent 6, 607, 744 B1, 2003 and US Patent 6, 866, 863 B2, 2005.

50. Disalvo, G.D., Cusick, J. Composition for indicating the prevailing temperature US Patent 6, 773, 637, 2004.

51. Hays, D.S. Diacetylene materials for sensing applications US Patent 20050101794 A1, 2005.

52. Volatile organic compounds. ASTM D2369 (VOC).

53. Rubber latex determination of surface tension. ISO Standard 1409-1974.

54. Standard test methods for rheological properties of Newtonian materials by rotational (Brookfield type) viscometer. ASTM D2196-99.

55. Rubber lattices determination of pH. ISO Standard 976-1986.

56. Product quality test method. Hexion Specialty Chemicals Samutsakorn Thailand.

APPENDICES

Appendix A : Latex formula

Table A1 : Formula of latex

Formula	Kind of Monomer			Rhodapex	Ammonia	Texanol
	EA	MAA	CM	CO-436	solution	
EA21/MAA14/E0.5	21	14	-	0.5	-	-
EA23/MMA15/E0.5	23	15	-	0.5	-	-
EA25/MAA14/E0.5	25	14	-	0.5	-	-
EA27/MAA18/E0.5	27	18	-	0.5	-	-
EA35/E0.5	35	-	-	0.5	-	-
EA29/MAA20/E0.5	29	20	-	0.5	-	-
EA30/MAA5/E0.5	30	5	-	0.5	-	-
EA25/MAA10/E0.5	25	10	-	0.5	-	-
EA21/MAA14/E0.5	21	14	-	0.5	-	-
EA15/MAA20/E0.5	15	20	-	0.5	-	-
EA13/MAA22/E0.5	13	22	-	0.5	-	-
EA21/MAA14/E0.5/CM	21	14	2.76	0.5	-	-
EA25/MMA10/E0.5/CM	25	10	2.76	0.5	-	-
EA21/MMA14/E0.3/CM	21	14	2.76	0.3	-	-
EA21/MMA14/E0.4/CM	21	14	2.76	0.4	-	-
EA21/MMA14/E0.75/CM	21	14	2.76	0.75	-	-
EA21/MMA14/E1.5/CM	21	14	2.76	1.5	-	-
EA21/MMA14/E0.5/CM/Am5	21	14	2.76	0.5	5	-
EA21/MMA14/E0.5/CM/Am10	21	14	2.76	0.5	10	-
EA21/MMA14/E0.5/CM/Am15	21	14	2.76	0.5	15	-
EA21/MMA14/E0.5/CM/Am20	21	14	2.76	0.5	20	-
EA21/MMA14/E0.5/CM/Am25	21	14	2.76	0.5	25	-

EA21/MMA14/E0.5/CM/ Tx5	21	14	2.76	0.5	-	5
EA21/MMA14/E0.5/CM/ Tx10	21	14	2.76	0.5	-	10
EA21/MMA14/E0.5/CM/ Tx15	21	14	2.76	0.5	-	15
EA21/MMA14/E0.5/CM/ Tx20	21	14	2.76	0.5	-	20
EA21/MMA14/E0.5/CM/ Tx25	21	14	2.76	0.5	-	25
EA31/MAA4/E0.5/CM	31	4	2.76	0.5	-	-
EA20/MAA15/E0.5	20	15	-	0.5	-	-
EA20/MAA15/E0.5/CM	20	15	2.76	0.5	-	-

EA = Ethyl acrylate MAA = Methacrylic acid

CM = Crosslinking monomers, nMA monomer : GMA monomer : EDGMA monomer 0.48 : 0.21 : 2.07 w/w ratio

Ammonia solution = 2.5% w/w (of solid)

Appendix B : Latexes specification

Table B1 : Specification of latexes

Latexes	%NV	Viscosity	pH
EA21/MAA14/E0.5	35	8	2.6
EA23/MMA14/E0.5	38	14	2.7
EA25/MAA17/E0.5	42	18	2.5
EA27/MAA18/E0.5	45	25	2.5
EA35/E0.5	35	8	2.5
EA29/MAA20/E0.5	49	8	2.6
EA30/MAA5/E0.5	35	9	2.6
EA25/MAA10/E0.5	35	12	2.6
EA21/MAA14/E0.5	35	9	2.6
EA15/MAA20/E0.5	35	9	2.6
EA13/MAA22/E0.5	35	9	2.7
EA21/MAA14/E0.5/CM	35	8	2.6
EA25/MMA10/E0.5/CM	35	11	2.6
EA21/MMA14/E0.3/CM	35	9	2.5
EA21/MMA14/E0.4/CM	35	9	2.5
EA21/MMA14/E0.75/CM	35	8	2.6
EA21/MMA14/E1.5/CM	35	8	2.5
EA21/MMA14/E0.5/CM/Am5	32.5	24.7	3.3
EA21/MMA14/E0.5/CM/Am10	30	53.9	3.7
EA21/MMA14/E0.5/CM/Am15	27.5	1,247	4.8
EA21/MMA14/E0.5/CM/Am20	25	7,800	5.6
EA21/MMA14/E0.5/CM/Am25	22.5	80,200	6.4
EA21/MMA14/E0.5/CM/Tx5	32.5	18.5	2.6
EA21/MMA14/E0.5/CM/Tx10	30	125.6	2.5
EA21/MMA14/E0.5/CM/Tx15	27.5	195	2.5
EA21/MMA14/E0.5/CM/Tx20	25	485	2.5
EA21/MMA14/E0.5/CM/Tx25	22.5	1,350	2.5
EA31/MAA4/E0.5/CM	35	9	2.6
EA20/MAA15/E0.5	35	8	2.6

EA20/MAA15/E0.5/CM	35	9	2.6

EA = Ethyl acrylate MAA = Methacrylic acid

CM = Crosslinking monomers, nMA monomer : GMA monomer : EDGMA monomer 0.48 : 0.21 : 2.07 w/w ratio

Ammonia solution = 2.5% w/w (of solid)

Appendix C: Glass transition temperature (T_g)

Table C1 : Glass transition temperature (T_g) of latexes by DSC technique

Latexes	On set	Mid point
EA35/E0.5	-29.99	-22.61
EA30/MAA5/E0.5	-1.1	4.04
EA25/MAA10/E0.5	14.38	21.30
EA21/MAA14/E0.5	35.58	47.30
EA18/MAA17/E0.5	49.67	64.61
EA13/MAA22/E0.5	124.78	135.92
EA21/MAA14/E0.5/CM2.76	42.15	47.30
EA25/MAA10/E0.5/CM2.76	21.26	28.78
EA21/MAA14/E0.5/CM2.76/Tx5	23.77	30.32
EA21/MAA14/E0.5/CM2.76/Tx10	2.10	11.16
EA21/MAA14/E0.5/CM2.76/Tx15	-8.59	-4.35
EA21/MAA14/E0.5/CM2.76/Tx20	-22.99	-22.61
EA21/MAA14/E0.5/CM2.76/Tx25	-42.06	-31.82

Figure C1 : Glass transition temperature (T_g) of EA35/E0.5

On set	Mid point
-29.99	-22.61

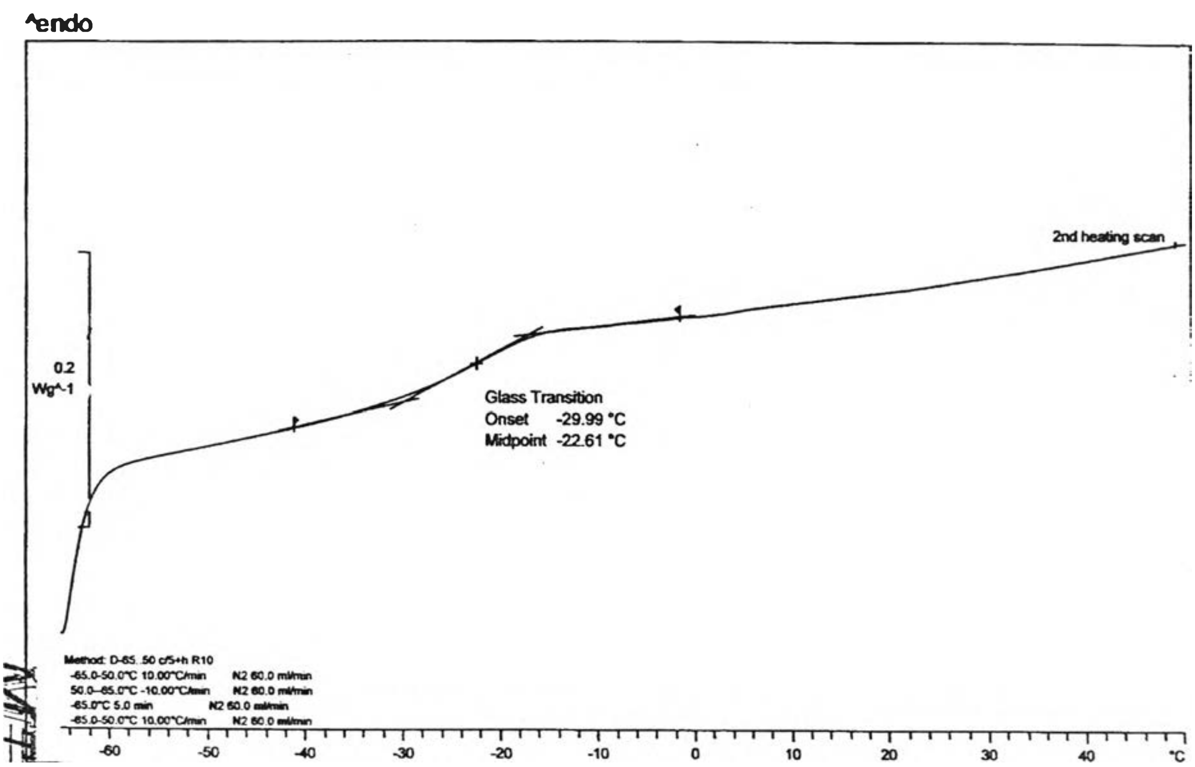


Figure C2 : Glass transition temperature (T_g) of EA35/E0.5

On set	Mid point
-1.1	4.04

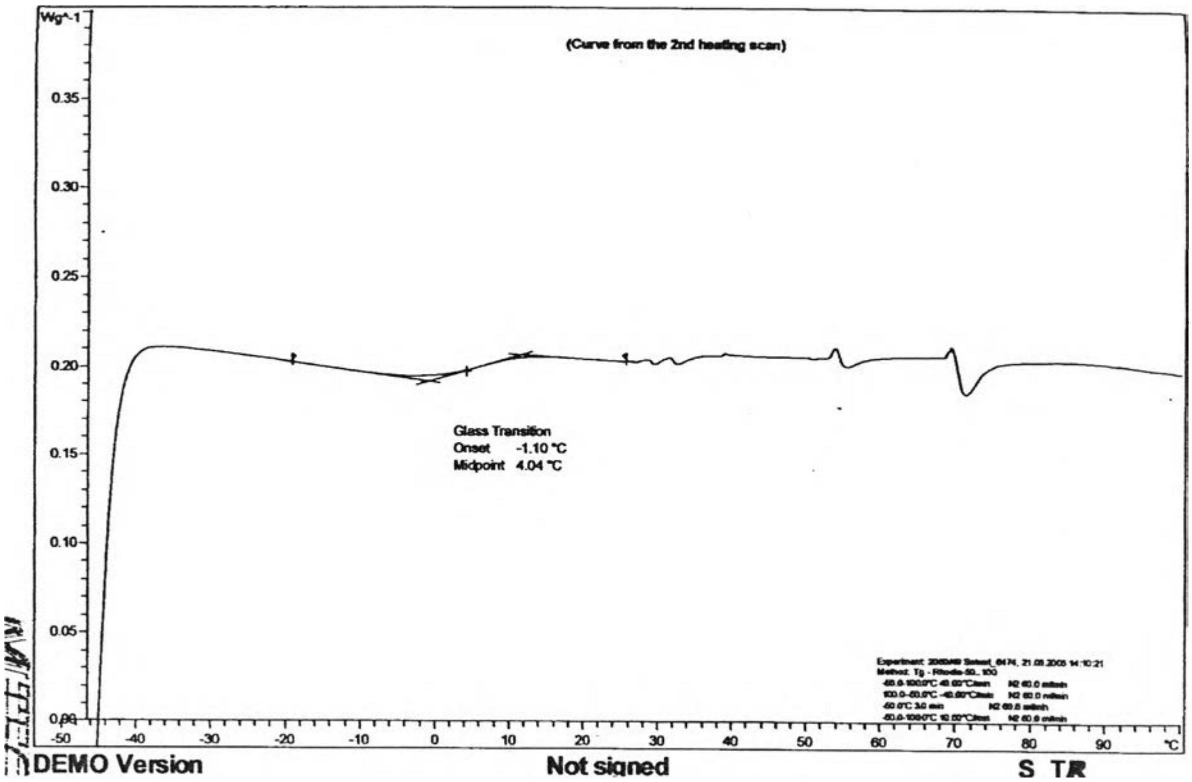


Figure C3 : Glass transition temperature (T_g) of EA25/MAA10/E0.5

On set	Mid point
14.38	21.30

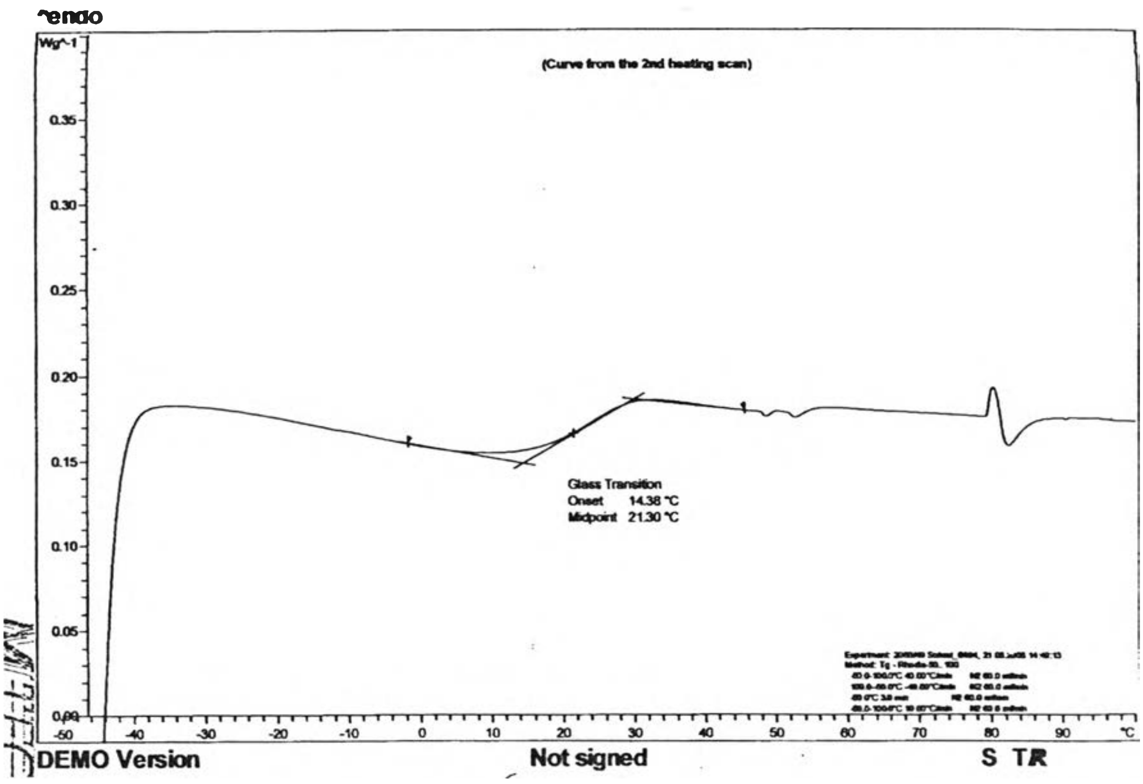


Figure C4 : Glass transition temperature (T_g) of EA21/MAA14/E0.5

On set	Mid point
35.58	47.30

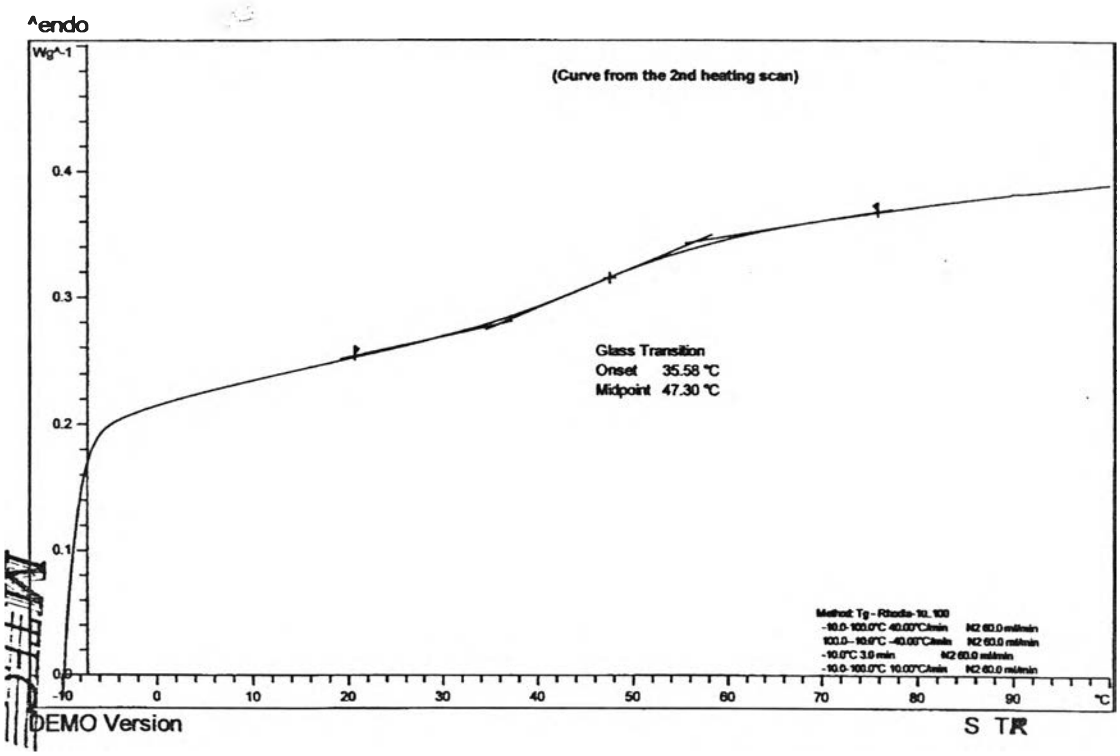


Figure C5 : Glass transition temperature (T_g) of EA18/MAA17/E0.5

On set	Mid point
49.67	64.61

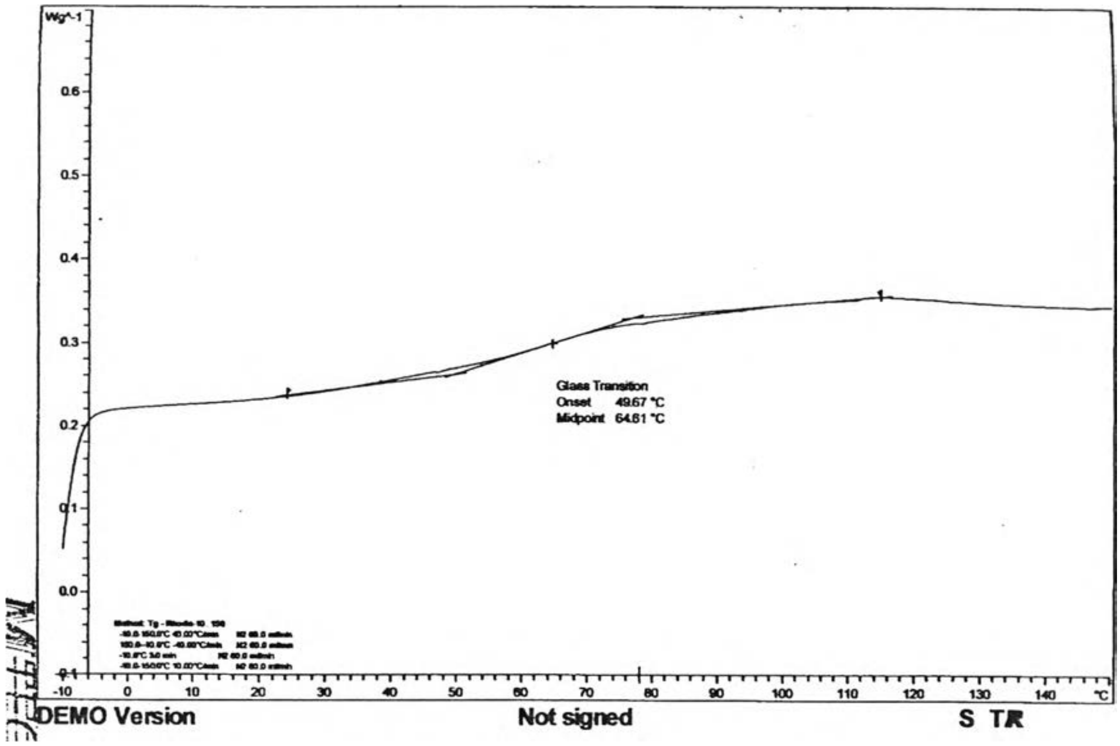


Figure C6 : Glass transition temperature (T_g) of EA13/MAA22/E0.5

On set	Mid point
124.78	135.92

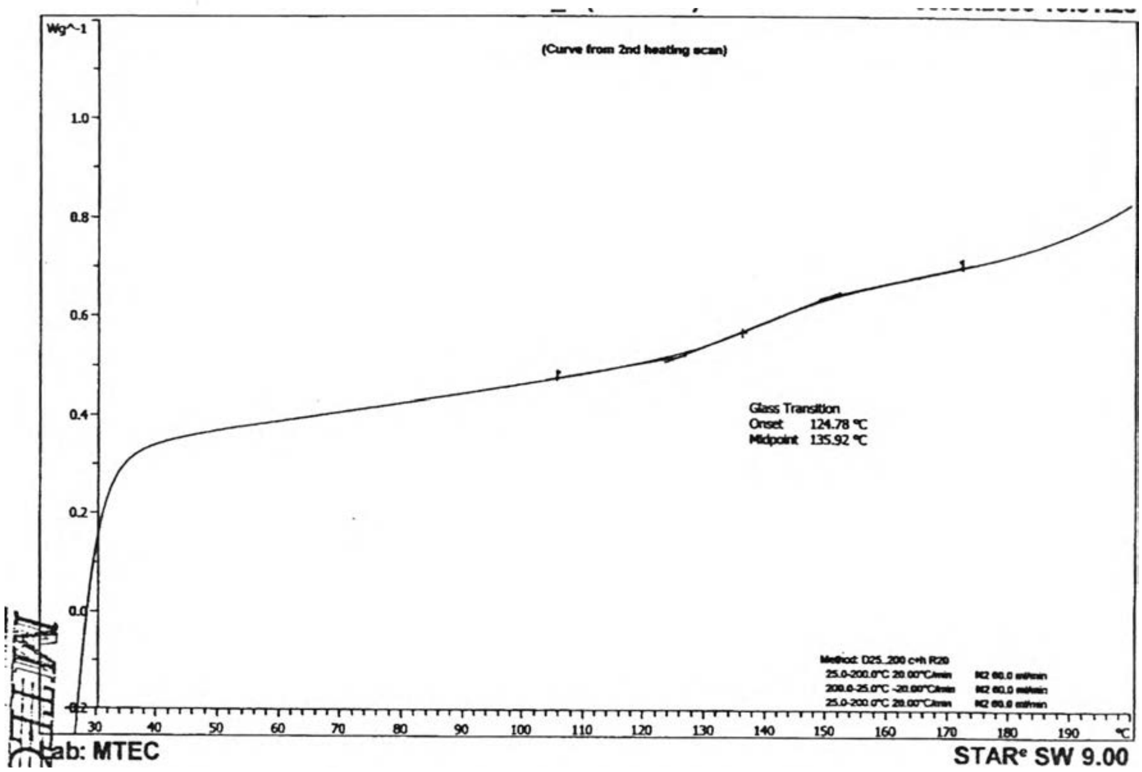


Figure C7 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76

On set	Mid point
42.15	47.30

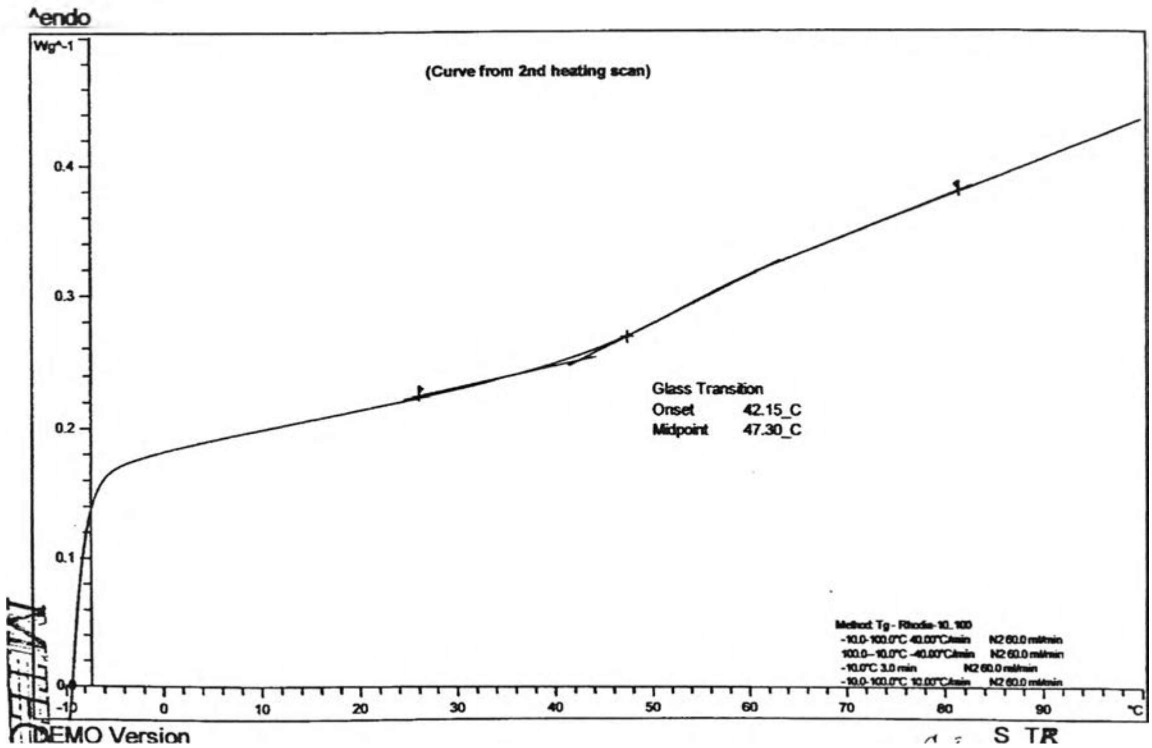


Figure C8 : Glass transition temperature (T_g) of EA25/MAA10/E0.5/CM2.76

On set	Mid point
21.26	28.78

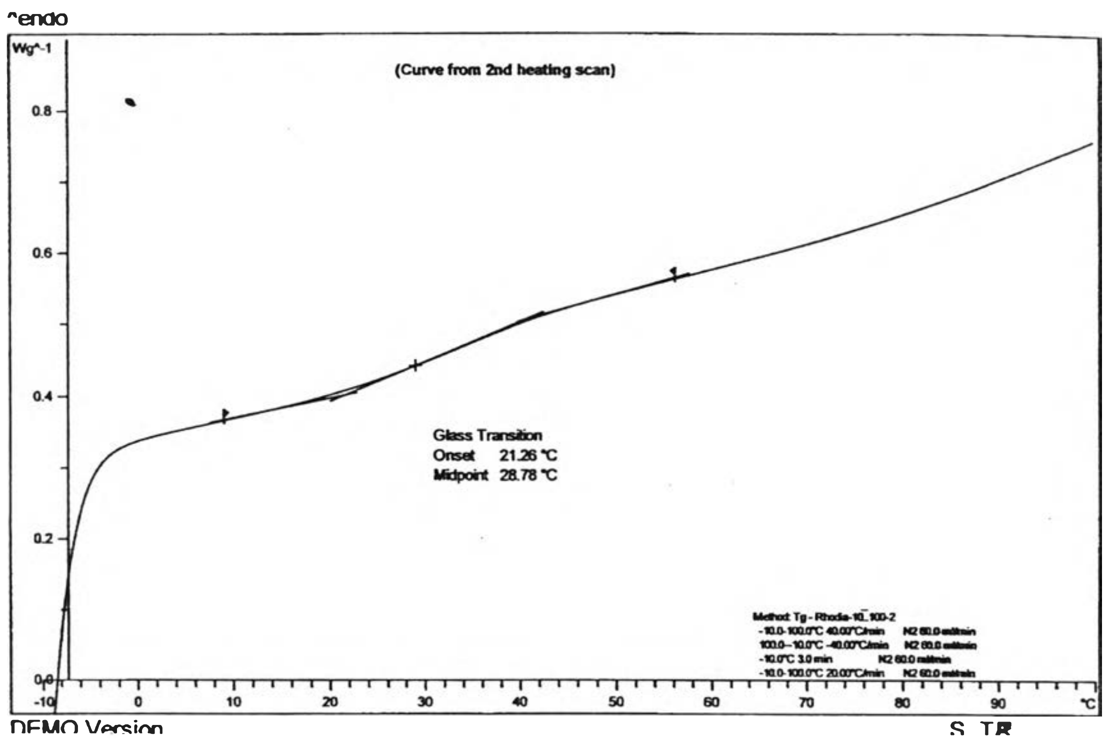


Figure C9 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76/Tx5

On set	Mid point
23.77	30.32

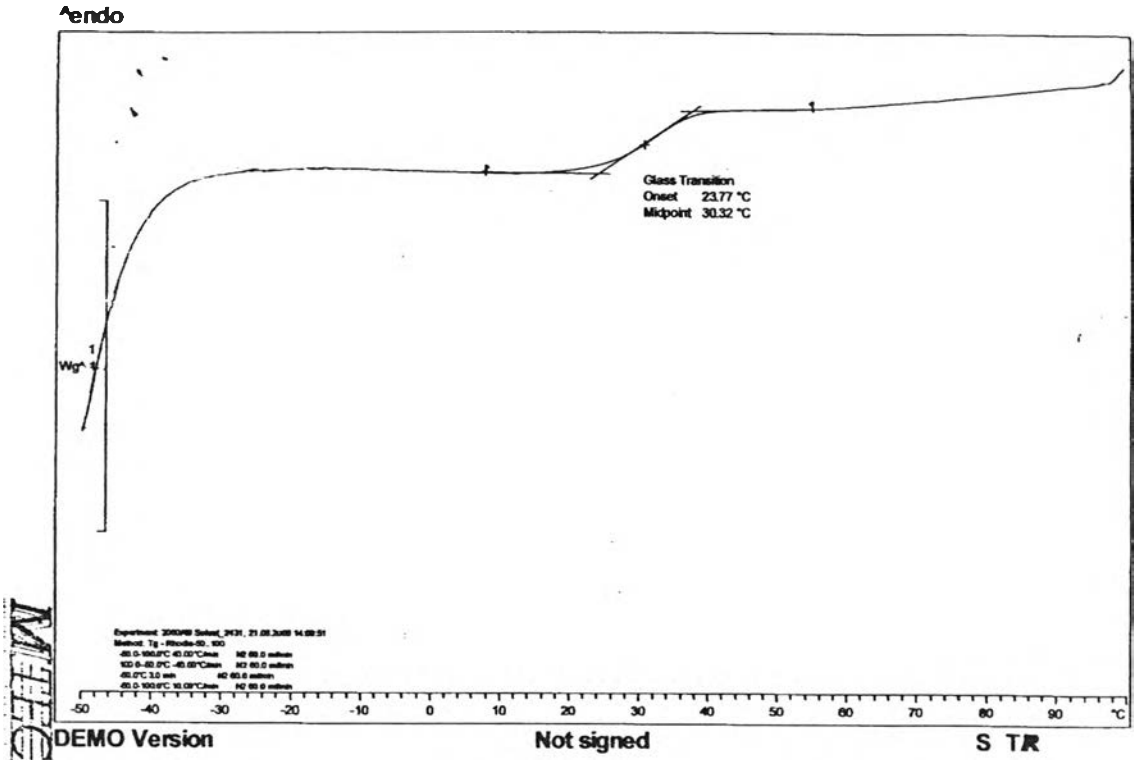


Figure C10 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76/Tx10

On set	Mid point
2.10	11.16

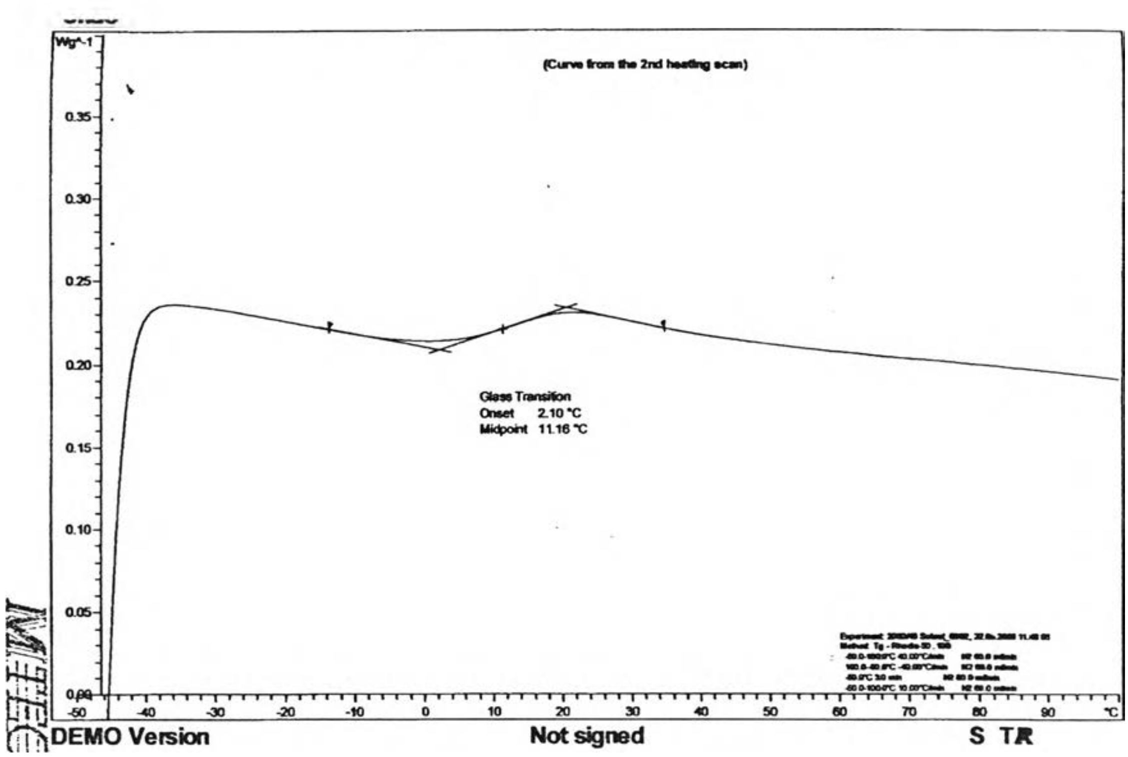


Figure C11 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76/Tx15

On set	Mid point
-8.59	-4.35

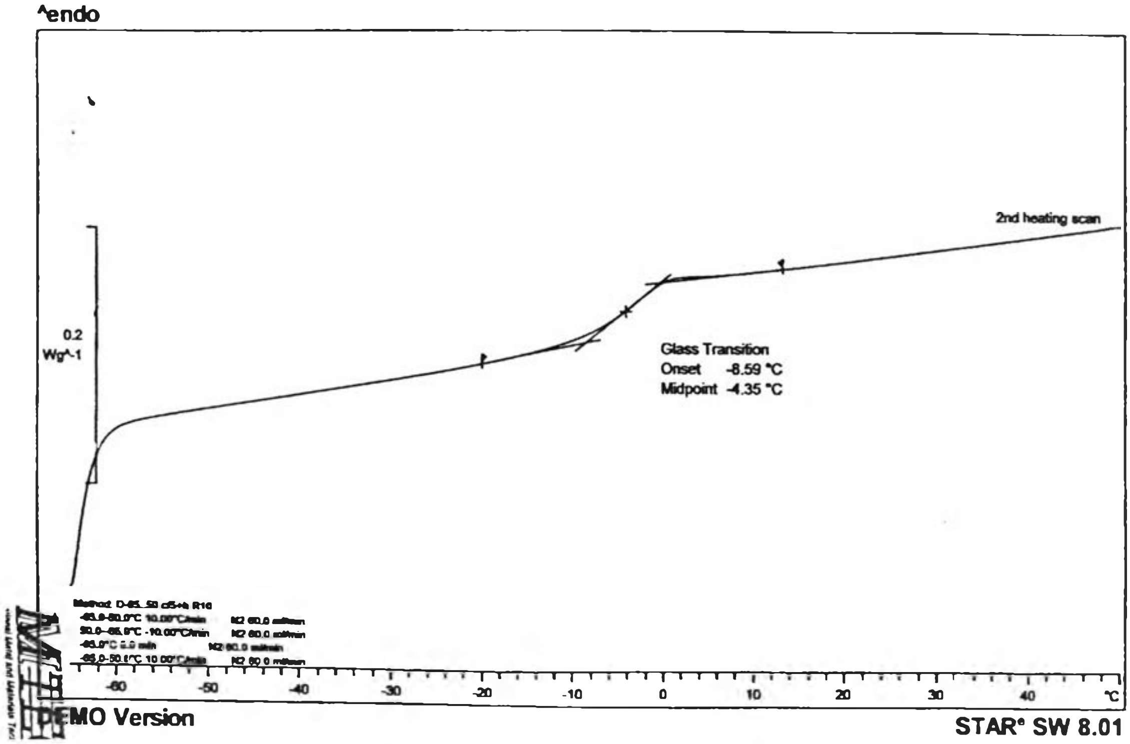


Figure C12 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76/Tx20

On set	Mid point
-22.99	-22.61

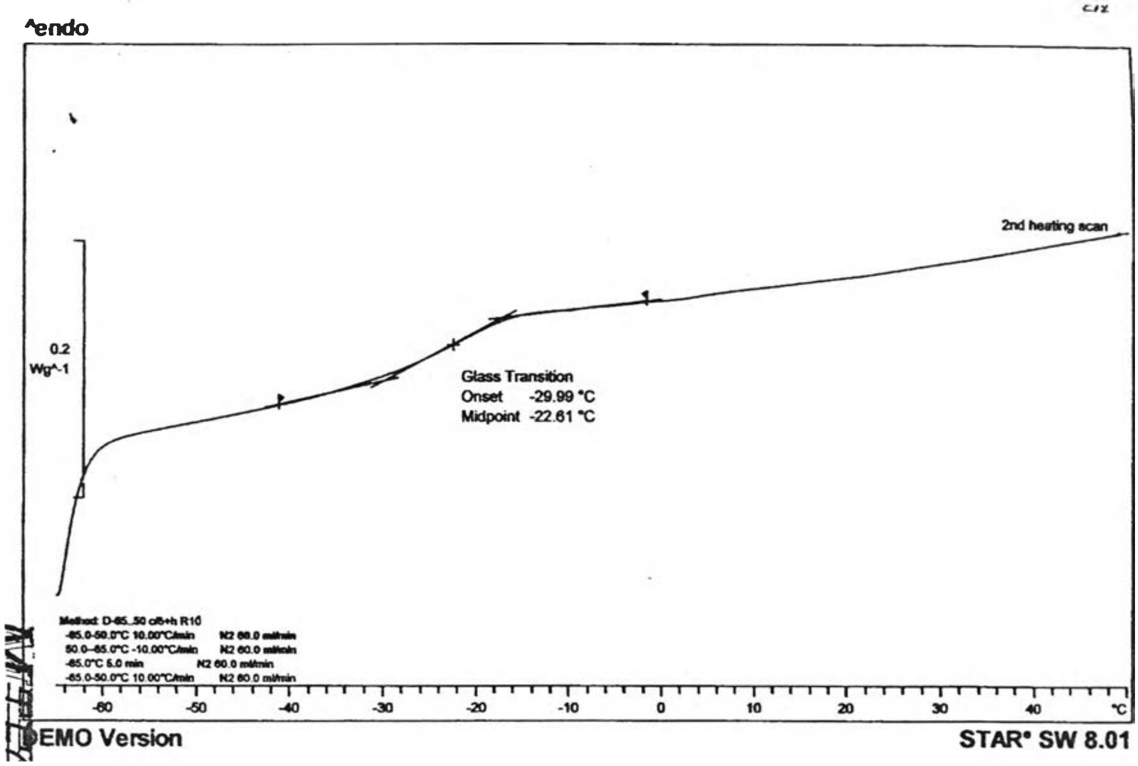


Figure C13 : Glass transition temperature (T_g) of EA21/MAA14/E0.5/CM2.76/Tx25

On set	Mid point
-42.06	-31.82

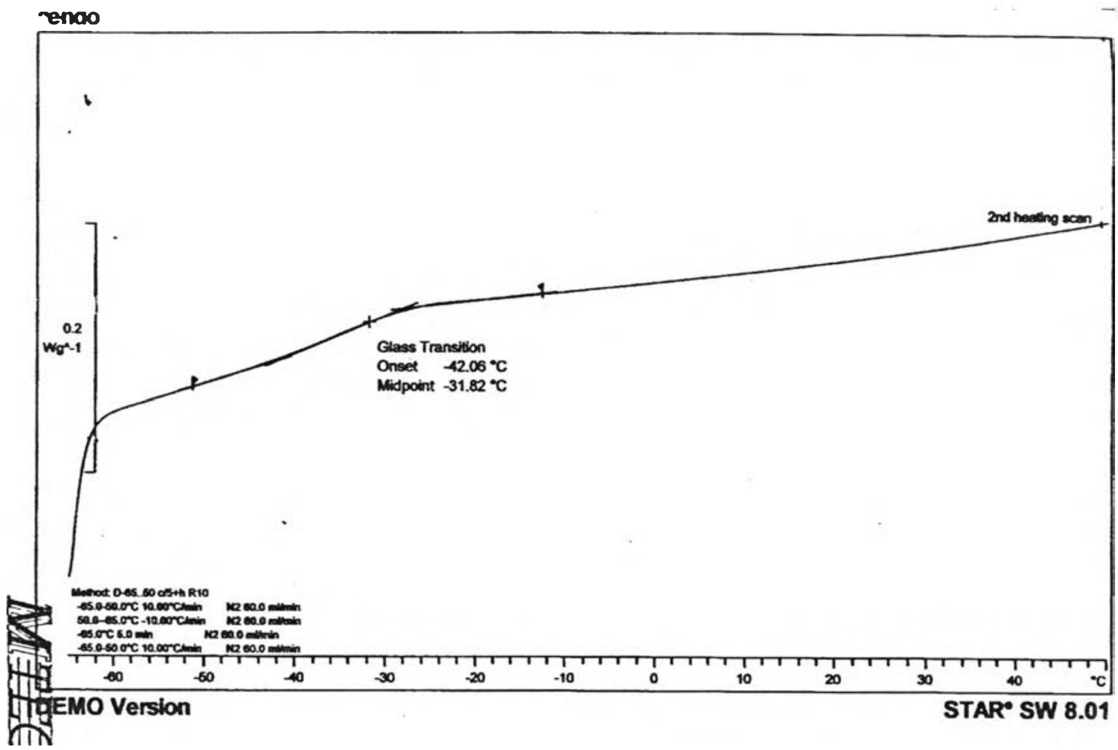
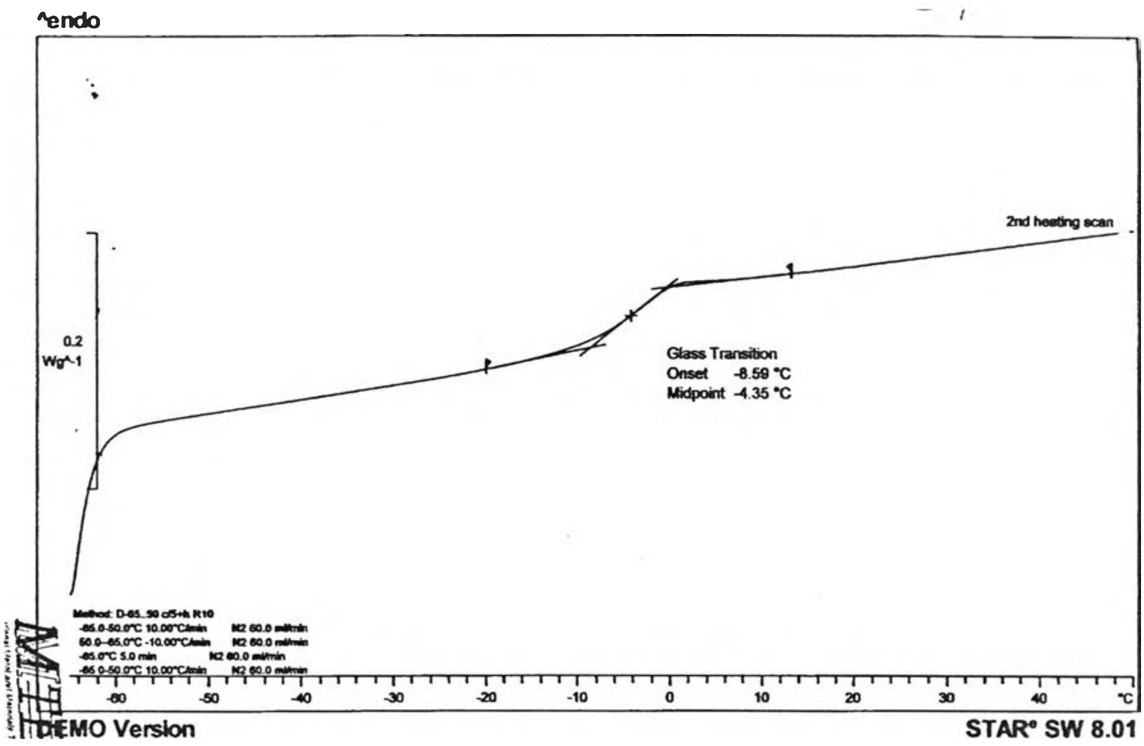


Figure C14 : Glass transition temperature (T_g) of EA35/E0.5/CM2.76

On set	Mid point
-8.59	-4.35



Appendix D: Particle size

Table D1: latex particle size

Latexes	Particle size (nm)				
	1	2	3	Mean	SD
Variation of monomer concentration					
EA21/MAA14/E0.5	95.5	95.6	95.5	95.5	0.06
EA23/MAA14/E0.5	96.8	96.9	96.9	96.9	0.06
EA25/MAA17/E0.5	98.0	98.2	98.4	98.2	0.20
EA27/MAA18/E0.5	105.6	107.2	103.1	105.3	2.07
Variation of emulsifier					
EA21/MAA14/E0.3/CM2.76	116.9	118.2	118.9	118.0	1.01
EA21/MAA14/E0.4/CM2.76	103.7	104.9	106.4	105.0	1.35
EA21/MAA14/E0.5/CM2.76	90.4	91.3	90.7	90.8	0.46
EA21/MAA14/E0.75/CM2.76	90.6	90.7	91.1	90.8	0.26
EA21/MAA14/E1.5/CM2.76	88.1	88.2	88.0	88.1	0.10
Addition of texanol					
EA21/MAA14/E0.5/CM2.76/Tx5	93.7	94.0	94.6	94.1	0.46
EA21/MAA14/E0.5/CM2.76/Tx10	95.9	95.9	95.7	95.8	0.12
EA21/MAA14/E0.5/CM2.76/Tx15	97.2	97.1	97.2	97.2	0.06
EA21/MAA14/E0.5/CM2.76/Tx20	98.6	98.9	98.9	98.8	0.17
EA21/MAA14/E0.5/CM2.76/Tx25	103.8	104.9	106.6	105.1	0.14

Figure D1 : Particle size distribution of EA21/MAA14/E0.5 latex

	Particle size (nm)
1st	95.5
2nd	95.6
3rd	95.5
Mean	95.5

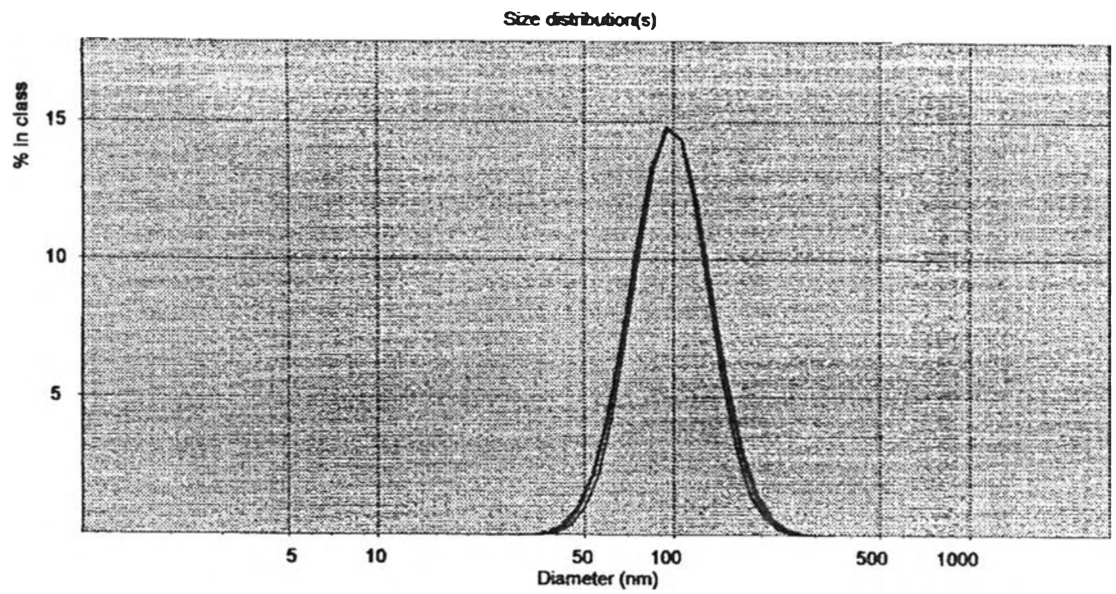


Figure D2 : Particle size distribution of EA23/MAA14/E0.5 latex

	Particle size (nm)
1^{st}	96.8
2^{nd}	96.9
3^{rd}	96.9
Mean	96.9

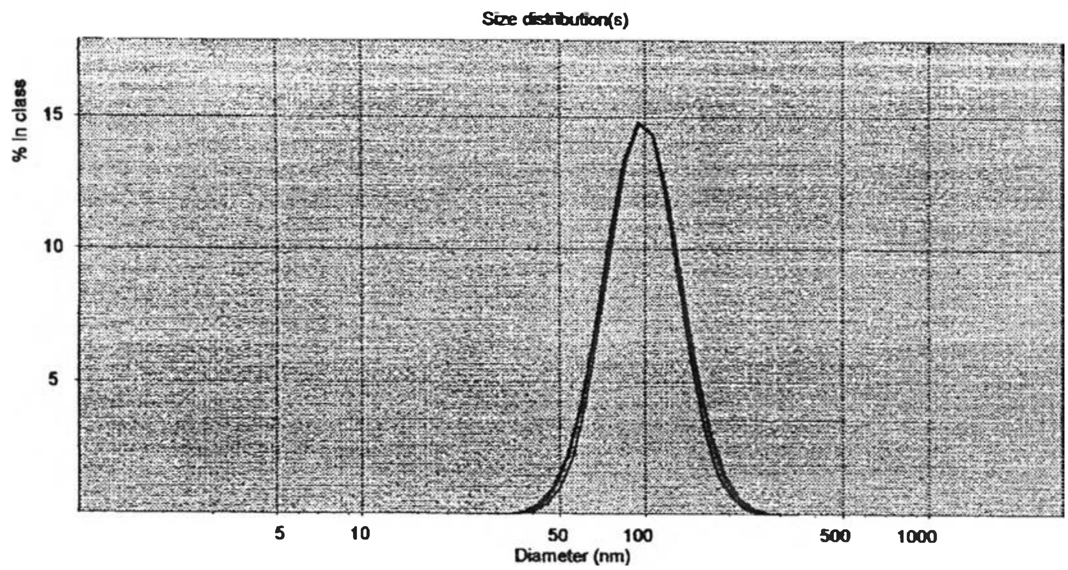


Figure D3 : Particle size distribution of EA25/MAA14/E0.5 latex

	Particle size (nm)
1st	98.0
2nd	98.2
3rd	98.4
Mean	98.2

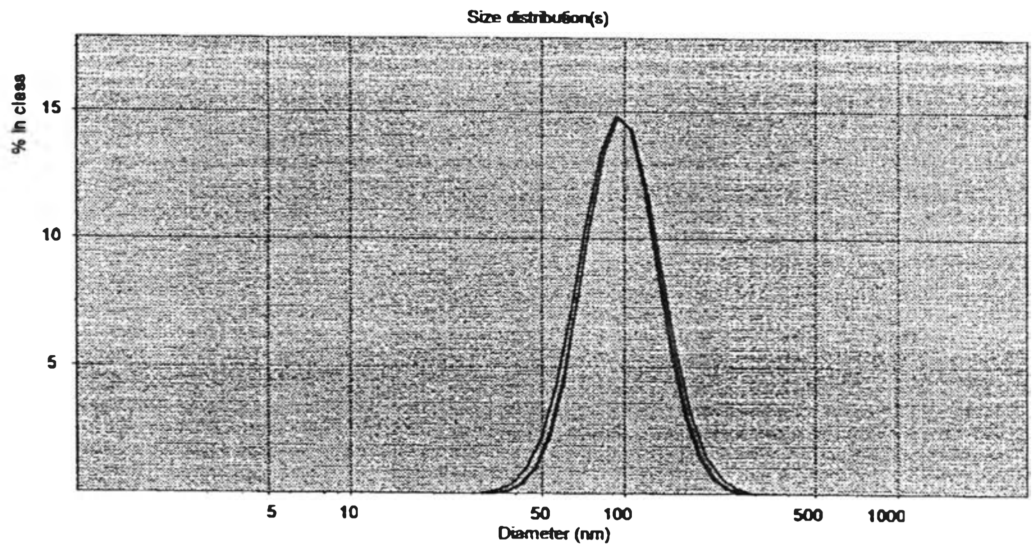


Figure D4 : Particle size distribution of EA27/MAA18/E0.5 latex

	Particle size (nm)
1st	105.6
2nd	107.2
3rd	103.1
Mean	105.3

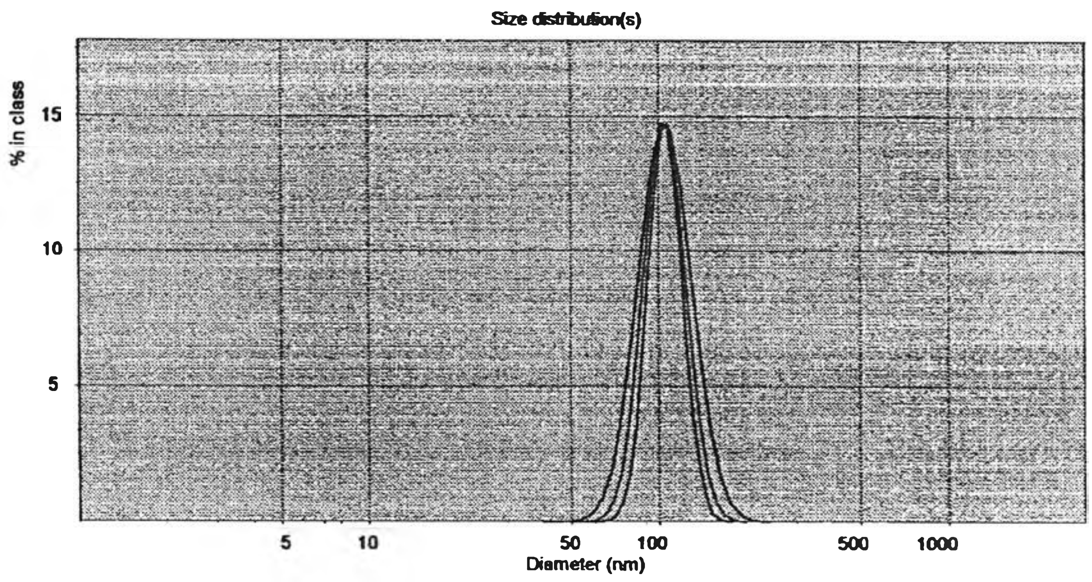


Figure D5 : Particle size distribution of EA21/MAA14/E0.3/CM2.76 latex

	Particle size (nm)
1st	116.9
2nd	118.2
3rd	118.9
Mean	118.0

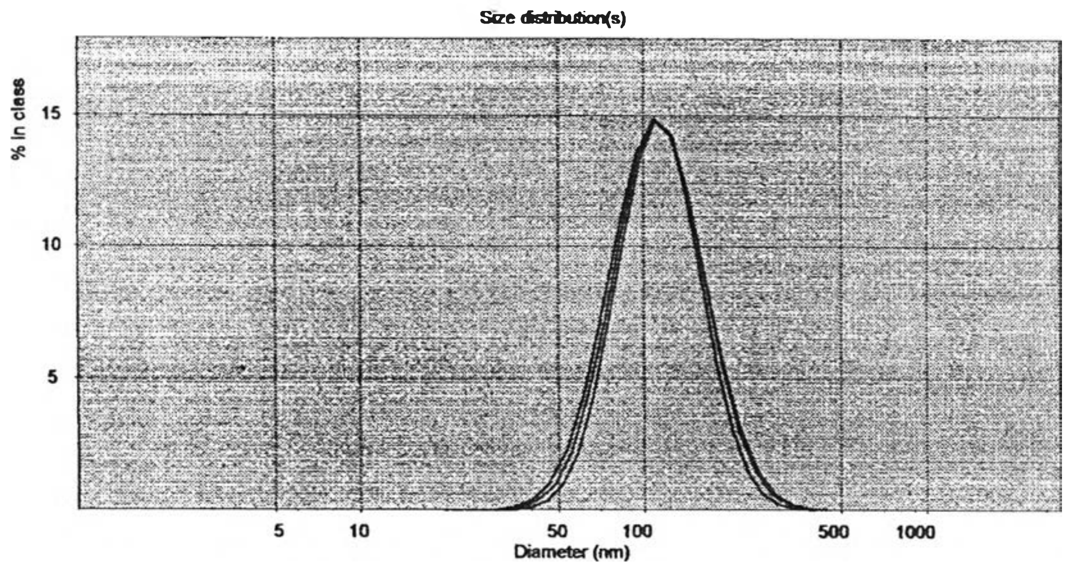


Figure D6 : Particle size distribution of EA21/MAA14/E0.4/CM2.76 latex

	Particle size (nm)
1st	103.7
2nd	104.9
3rd	106.4
Mean	105.0

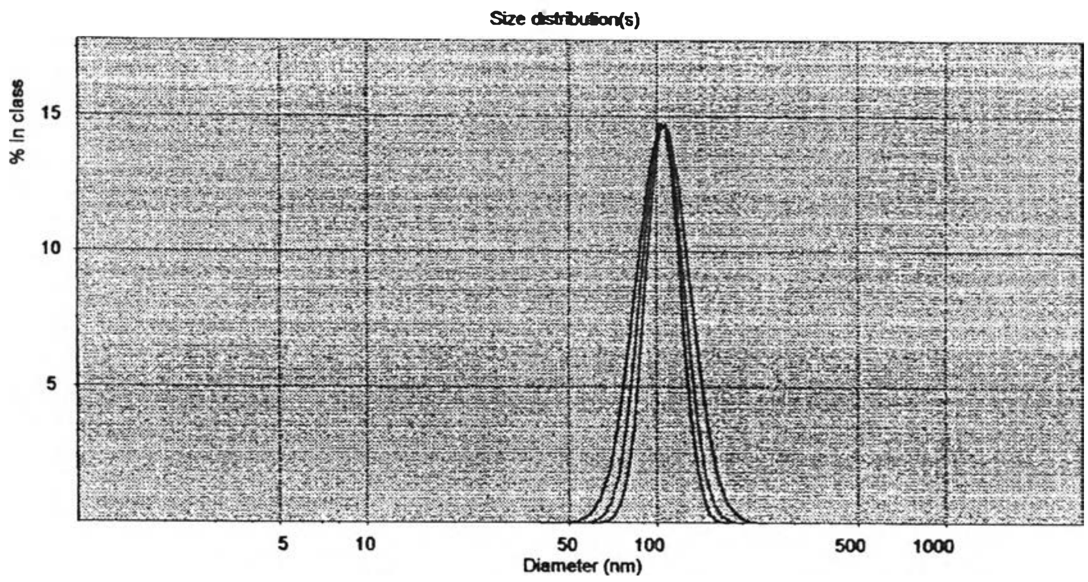


Figure D7 : Particle size distribution of EA21/MAA14/E0.5/CM2.76 latex

	Particle size (nm)
1st	90.4
2nd	91.3
3rd	90.7
Mean	90.8

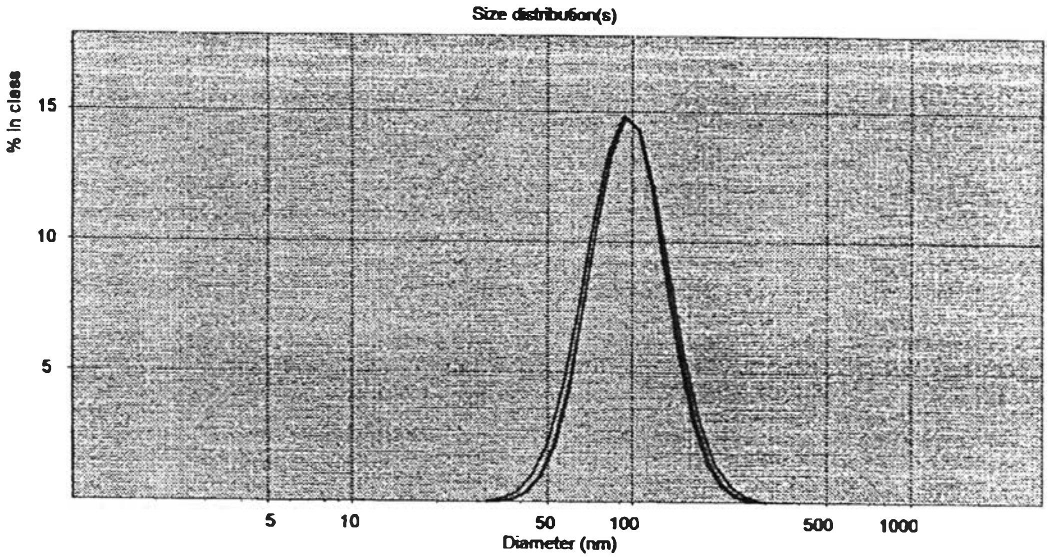


Figure D8 : Particle size distribution of EA21/MAA14/E0.75/CM2.76 latex

	Particle size (nm)
1st	90.6
2nd	90.7
3rd	91.1
Mean	90.8

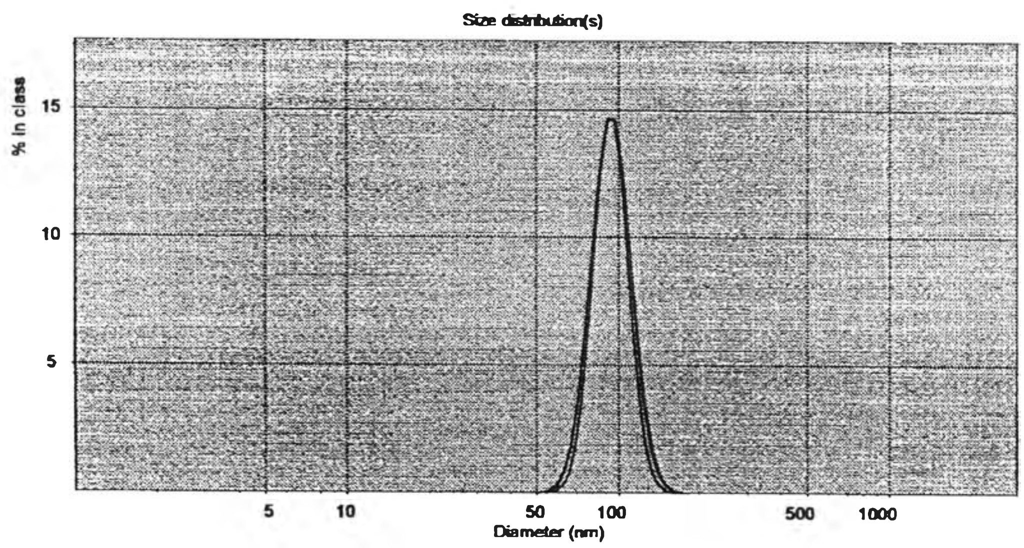


Figure D9 : Particle size distribution of EA21/MAA14/E1.5/CM2.76 latex

	Particle size (nm)
1st	88.1
2nd	88.2
3rd	88.0
Mean	88.1

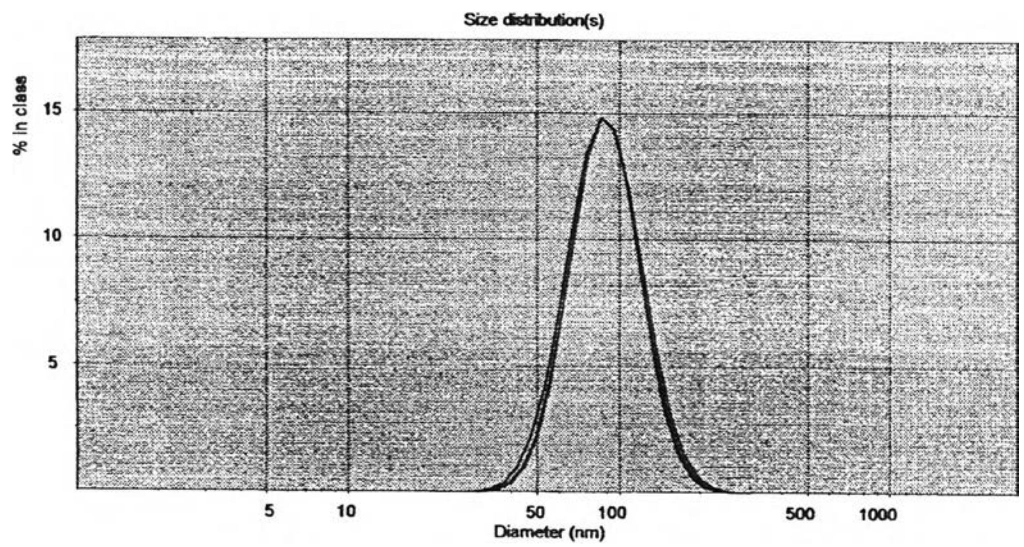


Figure D10 : Particle size distribution of EA21/MAA14/E0.5/CM2.76/Tx5 latex

	Particle size (nm)
1st	93.7
2nd	94.0
3rd	94.6
Mean	94.1

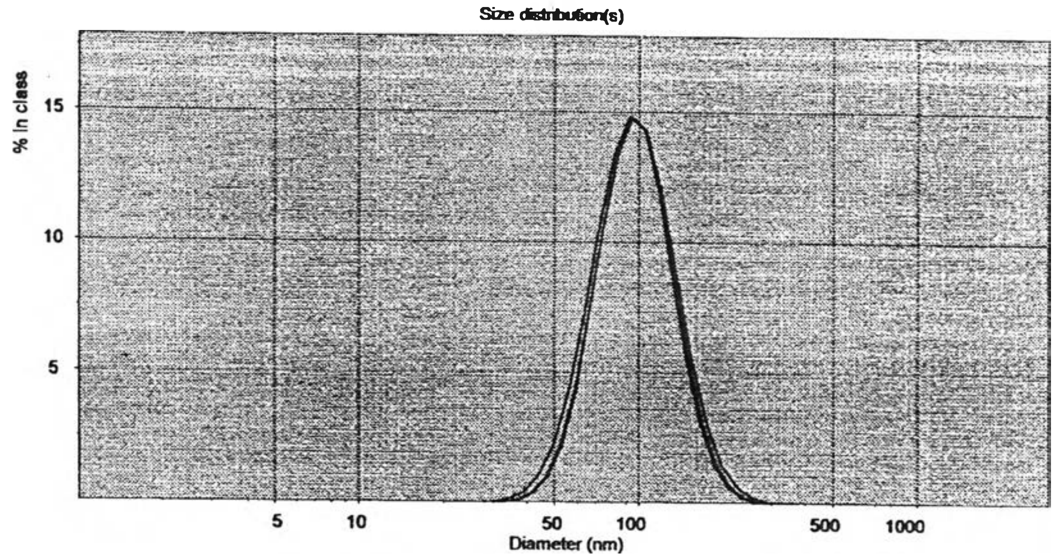


Figure D11 : Particle size distribution of EA21/MAA14/E0.5/CM2.76/Tx10 latex

	Particle size (nm)
1^{st}	95.9
2^{nd}	95.9
3^{rd}	95.7
Mean	95.8

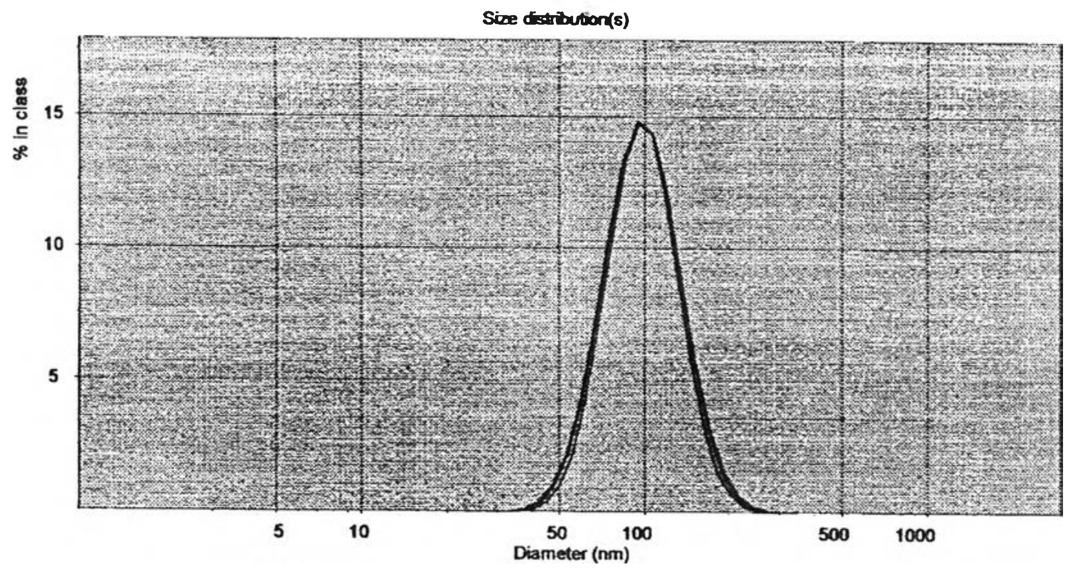


Figure D12 : Particle size distribution of EA21/MAA14/E0.5/CM2.76/Tx15 latex

	Particle size (nm)
1^{st}	97.2
2^{nd}	97.1
3^{rd}	97.2
Mean	97.2

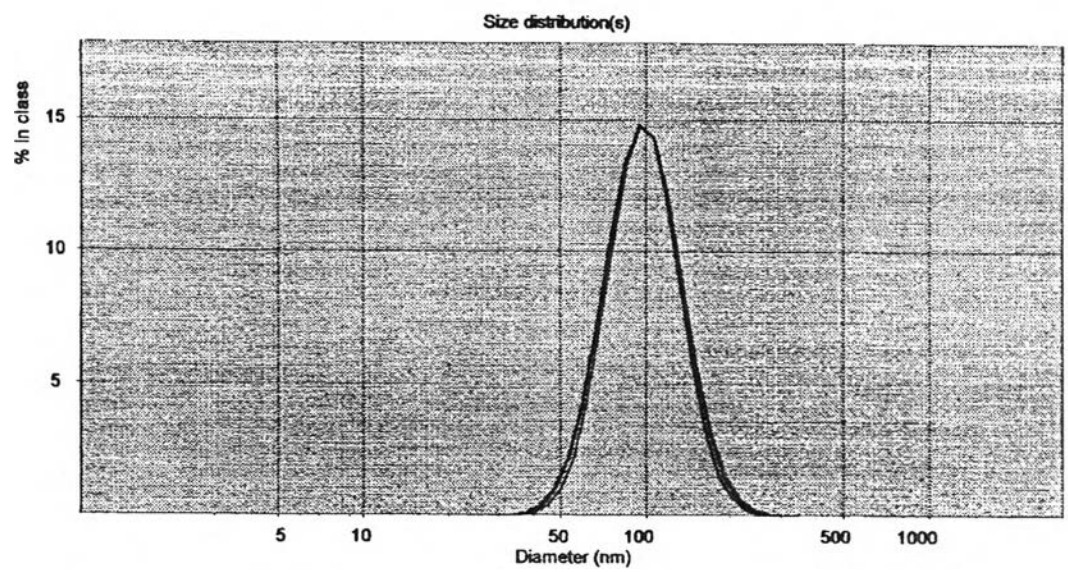


Figure D13 : Particle size distribution of EA21/MAA14/E0.5/CM2.76/Tx20 latex

	Particle size (nm)
1st	98.6
2nd	98.9
3rd	98.9
Mean	98.8

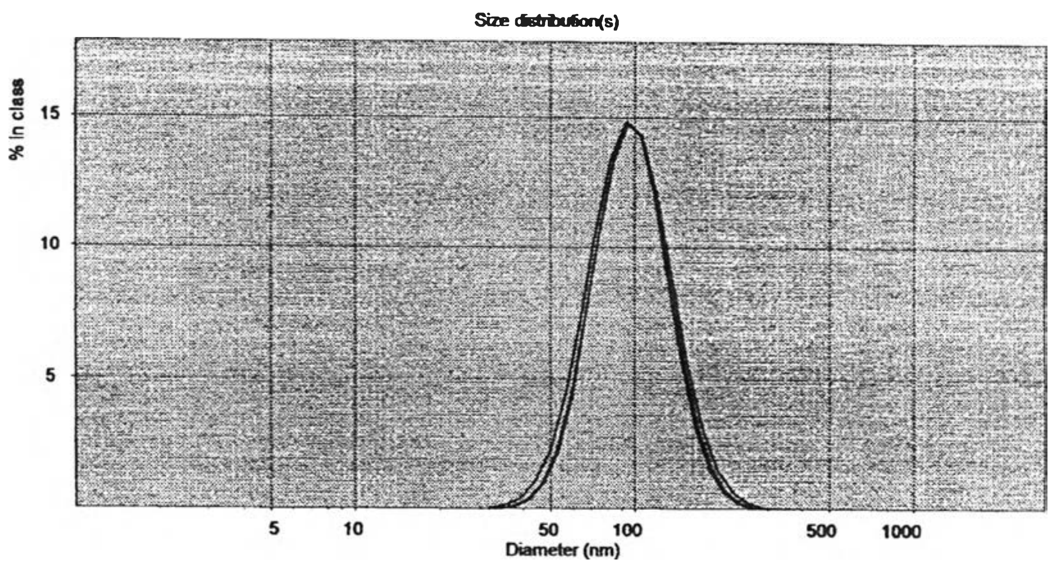
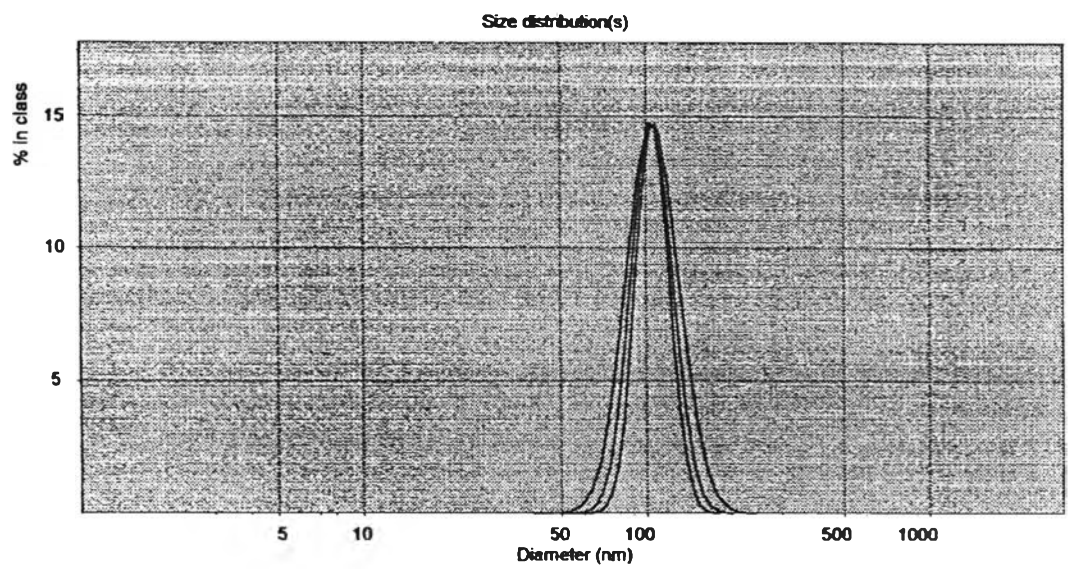


Figure D14 : Particle size distribution of EA21/MAA14/E0.5/CM2.76/Tx25 latex

	Particle size (nm)
1st	103.8
2nd	104.9
3rd	106.6
Mean	105.1



VITA

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