

## REFERENCES

- [1] Clair, K. S. Hydrocarbon Processing (April 2004): 39-43.
- [2] Ajayan, P.M.; Schadler, L.S. and Braun, P.V. Nanocomposite Science and Technology, WILEY-VCH Verlag GmbH Co. KGaA, Weinheim: 2003.
- [3] Verbeek, C.J.R. Mater. Lett. 56 (2002): 226.
- [4] Nawang, R.; Danjaji, I.D.; Ishiaku, U.S.; Ismail, H. and Mohd Ishak, Z.A. Polym. Testing 20 (2001): 167.
- [5] Haung, Y.; Jiang, S.; Wu, L. and Hua, Y. Polym. Testing 23 (2004): 9.
- [6] Huang, Y.Q.; Zhang, Y.Q. and Hua, Y.Q. J. Mater. Sci. Lett. 22 (2003): 997.
- [7] Danjaji, I.D.; Nawang, R.; Ishiaku, U.S.; Ismail, H. and Mohd Ishak, Z.A. Polym. Testing 21 (2002): 75.
- [8] Verbeek, C.J.R. Mater. Lett. 52 (2002): 453.
- [9] Kashiwa, N. and Imuta, J.Catalysis Surveys from Japan 1 (1997): 125-142.
- [10] Sinclair, K. B. and Wilson, R. B. Chemistry & Industry 7 (1994): 857-862.
- [11] Gupta, V. K.; Satish, S. and Bhardwaj, I. S. J. M. S.-Rev. Macromol. Chem. Phys. C34(3) (1994): 439-514.
- [12] Naga, N. and Imanishi, Y. Macromol. Chem. Phys. 203 (2002): 159-165.
- [13] Lauher, J. W. and Hoffmann, R. J. Am. Chem. Soc. 98 (1976): 1729.
- [14] Castonguay, L. A. and Rappe, A. K. J. Am. Chem. Soc. 114 (1992): 5832-5842.
- [15] Kaminsky, W. and Laban, K. Applied Catalysis A: General 222 (2001): 47-61.
- [16] Yang, X.; Stern, C. L. and Marks, T. J. J. Am. Chem. Soc. 113 (1991): 3623-3625.
- [17] Chien, J. C. W. and Wang, B. P. J. Polym. Sci.: Part A: Polym. Chem. 26 (1988): 3089-3102.
- [18] Pedoutour, J. N.; Radhakrishnan, K.; Cramail, H. and Deffieux, A. J. Mol. Cat. A: Chem. 185 (2002): 119-125.
- [19] Pedoutour, J. N.; Cramail, H. and Deffieux, A. J. Mol. Cat. A: Chem. 176 (2001): 87-94.
- [20] Cam, D. and Giannini, U. Makromol. Chem. 193 (1992): 1049-1055.
- [21] Soga, K.; Kim, H. J. and Shiono, T. Makromol. Chem., Rapid Commun. 14 (1993): 765-770.

- [22] Katayama, H.; Shiraishi, H.; Hino, T.; Ogane, T. and Imai, A. Macromol. Symp. 97 (1995): 109-118.
- [23] Przybyla, C.; Tesche, B. and Fink, G. Macromol. Rapid Commun. 20 (1999): 328-332.
- [24] Harkki, O.; Lehmus, P.; Leino, R.; Luttikhedde, H. J. G.; Nasman, J. H. and Seppala, J. V. Macromol. Chem. Phys. 200 (1999): 1561-1565.
- [25] Cheruvu, S. US Pat 5608019 (1997).
- [26] Albano, C.; Sanchez, G. and Ismayel, A. Polym. Bull. 41 (1998): 91-98.
- [27] Shan, C. L. P.; Soares, J. B. P. and Penlidis, A. J. Polym. Sci.: Part A: Polym Chem. 40 (2002): 4426-4451.
- [28] Pietikainen, P. and Seppala, J.V. Macromolecules 27 (1994): 1325-1328.
- [29] Soga, K. and Kaminaka, M. Makromol. Chem. Rapid Commun. 13 (1992): 221-224.
- [30] Nowlin, T. E.; Kissin, Y. V. and Wagner, K. P. J. Polym. Sci.: Part A: Polym. Chem. 26 (1988): 755-764.
- [31] Chu, K. J.; Soares, J. B. P. and Penlidis, A. Macromol. Chem. Phys. 201 (2000): 340-348.
- [32] Soga, K.; Uozumi, T.; Arai, T. and Nakamura, S. Macromol. Rapid Commun. 16 (1995): 379-385.
- [33] De Fatima, V.; Marques, M.; Conte, A.; de Resende, F. C. and Chaves, E. G. J. App. Polym. Sci. 82 (2001): 724-730.
- [34] Kim, J. D. and Soares, J. B. P. Macromol. Rapid Commun. 20 (1999): 347-350.
- [35] Chu, K. J.; Soares, J. B. P. and Penlidis, A. Journal of Polymer Science:Part A: Polymer Chemistry. 38 (2000): 462-468.
- [36] Chu, K. J.; Shan, C. L. P.; Soares, J. B. P. and Penlidis, A. Macromol. Chem. Phys. 200 (1999): 2372-2376.
- [37] Shan, C. L. P.; Chu, K. J.; Soares, J. and Penlidis, A. Macromol. Chem. Phys. 201 (2000): 2195-2202.
- [38] Steinmetz, B.; Tesche, B.; Przybyla, C.; Zechlin, J. and Fink, G. Acta Polymer 48 (1997): 392-399.
- [39] Tait, P. J. T. and Monterio, M. G. K. Mecton'96, Houston, TX, USA June (1996).
- [40] Quijada, R.; Rojas, R.; Alzamora, L.; Retuert, J. and Rabagliati, F. M. Catalysis letters 46 (1997): 107-112.

- [41] Chen, Y. X.; Rausch, M. D. and Chein, J. C. W. J. Polym. Sci.: Part A: Polym. Chem. 33 (1995): 2093-2108.
- [42] Ban, H.; Arai, T.; Ahn, C. H.; Uozumi, T. and Soga, T. Recent Development in Heterogeneous Metallocene Catalyst.
- [43] Ferreira, M. L.; Belelli, P. G.; Juan, A. and Damiani, D. E. Macromol. Chem. Phys. 201 (2000): 1334-1344.
- [44] Jordana, J.; Jacob, K.I.; Tannenbaum, R. Sharaf, M.A. and Jasiuk, I. Materials Science and Engineering A 393 (2005): 1-11.
- [45] Chan, C.M.; Wu, J.; Li, J.X. and Cheung, Y.K. Polymer 43 (2002): 2981-2992.
- [46] Vollenberg, P.H.T. and Heikens, D. Polymer 30 (1989):1656-1662).
- [47] Petrovic, Z.S.; Javni, I. A.; Waddon, G. and Banhegyi, J. Appl. Polym. Sci. 76 (2000): 133-151.
- [48] Ash, B.J.; Stone, J.; Rogers, D.F.; Schadler, L.S.; Siegel, R.W.; Benicewicz, B.C. and Apple, T. Mater. Res. Soc. Symp. Proc. 661 (2000).
- [49] Ash, B.J.; Schadler, L.S. and Siegel, R.W. Mater. Lett. 55 (2002): 83-87.
- [50] Tadd, E.; Zeno, A.; Zubris, M.; Dan, N. and Tannenbaum, R. Macromolecules. 36 (2003): 6497-6502.
- [51] Wang, K.H.; Chung, I.J.; Jang, M.C.; Keum, J.K. and Song, H.H. Macromolecules. 35 (2002): 5529-5535.
- [52] Reynaud, E.; Jouen, T.; Gauthier, C. and Vigier, G. Polymer 42 (2001): 8759-8768.
- [53] Ranade, A., D'Souza, N.A. and Gnade, B. Polymer 43 (2002): 3759-3766.
- [54] Lopez, D.; Cendoya, I.; Torres, F.; Tejada, J. and Mijangos, C. J. Appl. Polym. Sci. 82 (2001): 3215-3222.
- [55] Masenelli-Varlot, K.; Reynaud, E.; Vigier, G. and Varlet, J. J. Polym. Sci. B: Polym. Phys. 40(2002): 272-283.
- [56] Zhang, Y.; Ge, S.; Tang, B.; Rafailovich, M.H.; Sokolov, J.C.; Peiffer, D.G.; Li, Z.; Dias, A.J.; McElrath, K.O.; Satija, S.K.; Lin, M.Y. and Nguyen, D. Langmuir 17 (2001): 4437-4442.
- [57] Friedlander, S.K.; Ogawa, K. and Ullmann, M. J. Polym. Sci. B: Polym. Phys. 38 (2000): 2658-2665.
- [58] Hotta, S. and Paul, D.R. Polymer 45 (2004): 7639-7654.

- [59] Wang, K. H.; Choi, M. H.; Koo, C. M.; Choi, Y. S. and Chung, I. J. Polymer 42 (2001): 9819-9826 .
- [60] Lew, C. Y.; Murphy, W. R. and McNally, G. M. Polym. Eng. Sci. 44 (2004): 1027-1035.
- [61] Chuang, T. H. ; Guo, W.; Cheng, K. C.; Chen, S.W.; Wang, H.T. and Yen, Y. Y. Journal of Polymer Research11(2004): 169 – 174.
- [62] Benjamin, J. A , Diana F. R , Christopher J. W ,Linda .S, Richard W. S ,  
,Polymer Composites Vol. 23,(2002) 1014-1025
- [63] Rui, Y, Ying, L and Jian, Y, Polymer Degradation and Stability,88(2005) 168-174
- [64] Kuo, M.C., Tsai C.M. , Huang, J.C. and Chen, M. .,Materials Chemistry and Physics, 90 (2005) 185-195
- [65] Kuo, M.C. , Huang, J.C. , Chen, M. Chen Materials Chemistry and Physics (2005)
- [66] Praveen, B , David, L. B , Jason, A, W, Gregory ,S, C. Gregory, T, Richard, W. S ,  
, Linda, S. S, Wear 258 (2005) 1437– 1443
- [67] Jongsomjit, B.; Prasertthdam, P., P. Mater. Chem. Phys. 86 (2004): 243.
- [68] Jongsomjit, B.; Chaichana, E. and Prasertthdam, P. Sci. 40 (2005): 2043-2045.
- [69] Jongsomjit, B.; Kaewkrajang, P.; Shiono, T. and Prasertthdam, P. Ind. Eng. Chem. Res. 43 (2004): 7959.
- [70] Chao, C.; Prasertthdam, P.; Khorbunsongserm, S. and Rempel, G.L. J. Macromol. Sci., Part A: Pure Appl. Chem. 40 (2003): 181.
- [71] Kogelbauer, A.; Weber, J. C. and Goodwin, Jr., J. G. Catal. Lett. 34 (1995): 259.
- [72] Jongsomjit. B.; Panpranot, J.; Goodwin, Jr., J. G. J. Catal. 204 (2001): 98.
- [73] Randall, J. C. J. Macromol. Sci., Rev. Macromol. Chem. Phys. C29 (1989): 201.
- [74] Galland, G. B.; Quijada, P.; Mauler, R. S. and de Menezes, S. C. Macromol. Rapid Commun. 17 (1996): 607.
- [75] Jongsomjit, B.; Kaewkrajang, P.; Wanke, S. E. and Prasertthdam, P. Catal. Lett. 94 (2004): 205.
- [76] Jongsomjit, B.; Ngamposri, S. and Prasertthdam, P. Catal. Lett. 100 (2005): 139.
- [77] Jongsomjit, B.; Ngamposri, S. and Prasertthdam, P. Molecules. 10 (2005): 672.
- [78] Jongsomjit, B.; Ngamposri, S. and Prasertthdam, P. Ind. Eng. Chem. Res. 44 (2005): 9059.

## **APPENDICES**

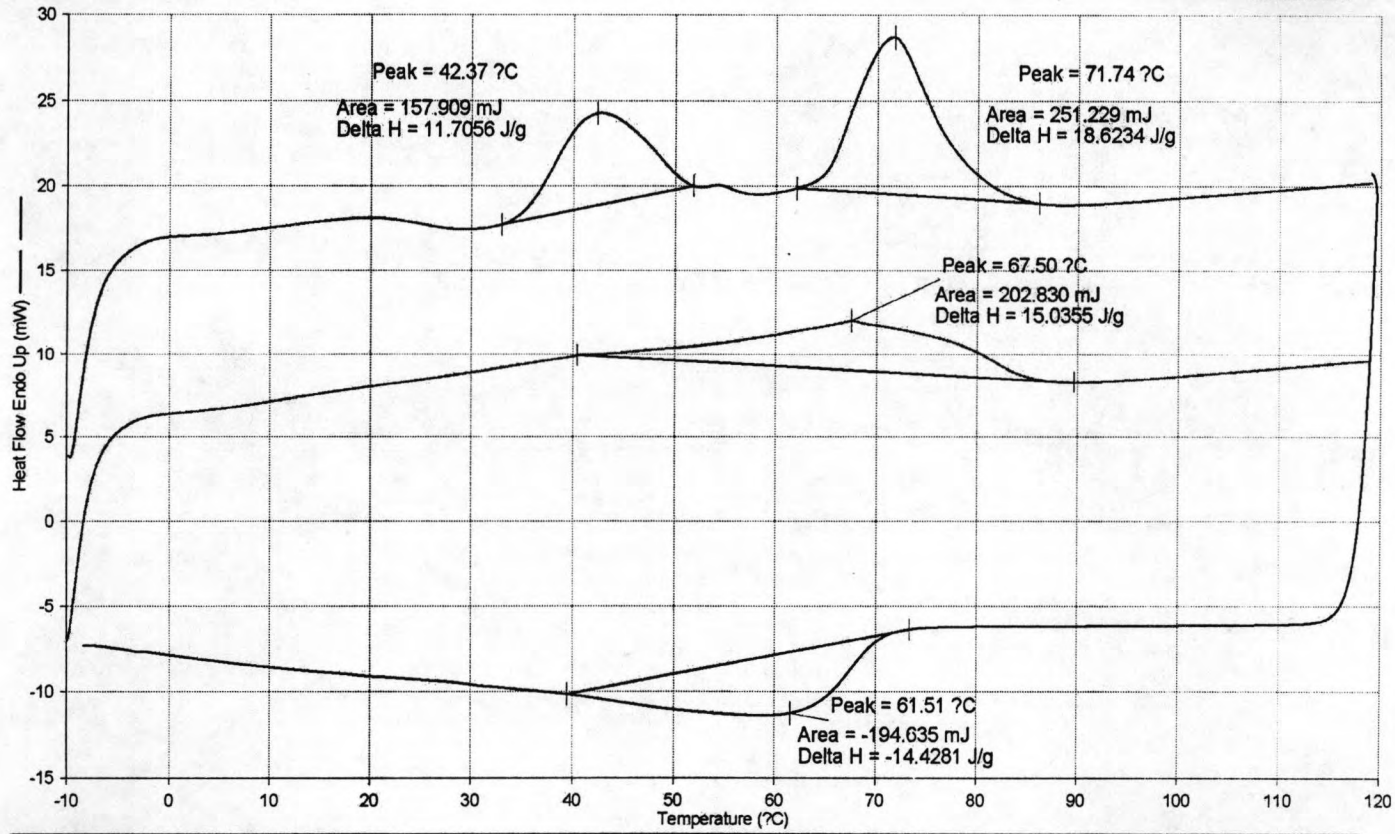


## **APPENDIX A**

### **Differential Scanning Calorimeter**

Sample ID: Homo 1-hexene  
Sample Weight: 13.490 mg

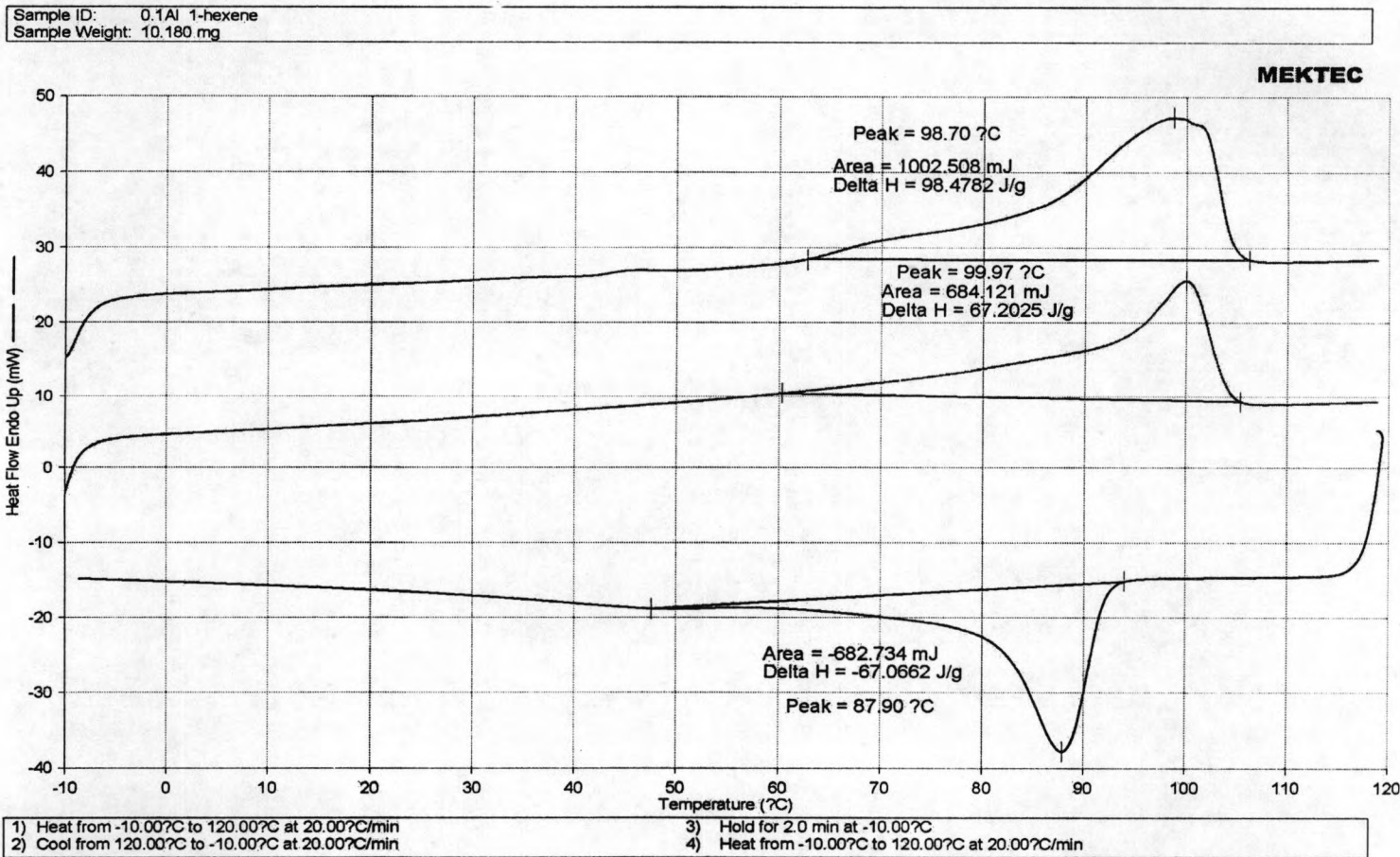
MEKTEC



1) Heat from -10.00°C to 120.00°C at 20.00°C/min  
2) Cool from 120.00°C to -10.00°C at 20.00°C/min

3) Hold for 2.0 min at -10.00°C  
4) Heat from -10.00°C to 120.00°C at 20.00°C/min

Figure A-1. DSC curve of LLDPE-homogeneous at Al/Zr = 1135



**Figure A-2.** DSC curve of LLDPE-nanocomposites with 0.1 g of nano-Alumina



Sample ID: 0.2Al 1-hexene  
Sample Weight: 10.830 mg

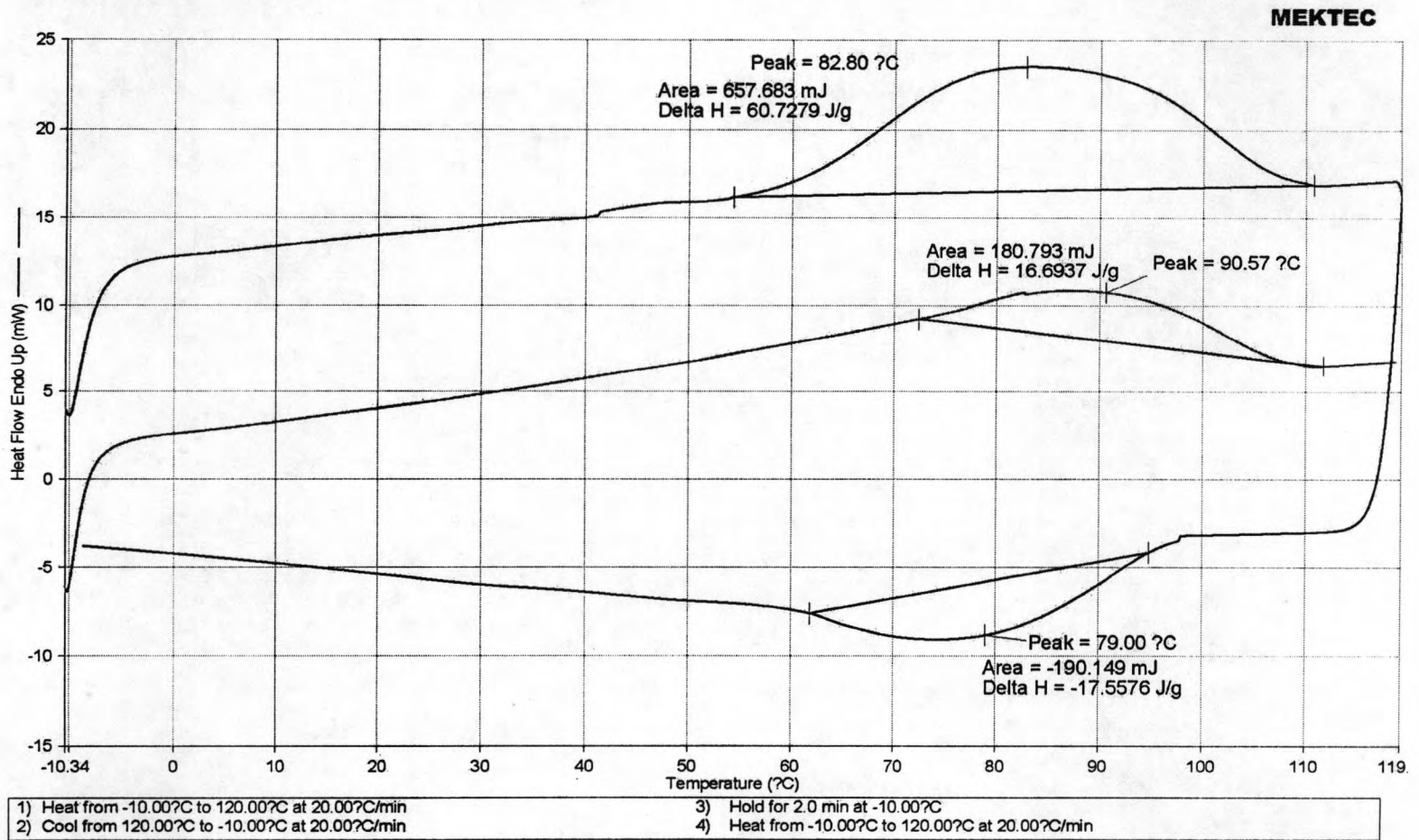
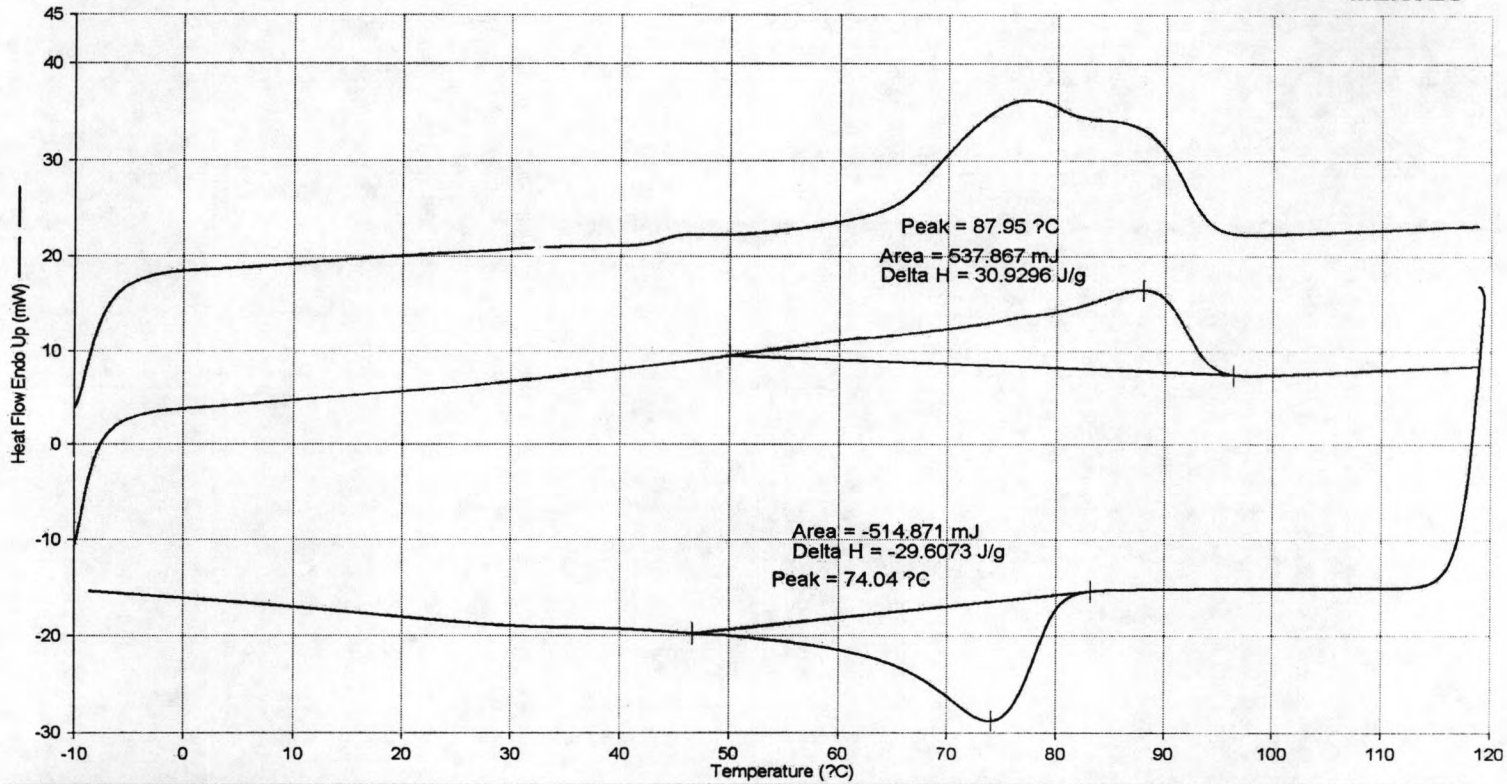


Figure A-3. DSC curve of LLDPE-nanocomposites with 0.2 g of nano-Alumina

Sample ID: 0.3Al 1-hexene  
Sample Weight: 17.390 mg

MEKTEC



1) Heat from -10.00°C to 120.00°C at 20.00°C/min  
2) Cool from 120.00°C to -10.00°C at 20.00°C/min  
3) Hold for 2.0 min at -10.00°C  
4) Heat from -10.00°C to 120.00°C at 20.00°C/min

Figure A-4. DSC curve of LLDPE-nanocomposites with 0.3 g of nano-Alumina

Sample ID: 0.2 Al 1135  
Sample Weight: 4.800 mg

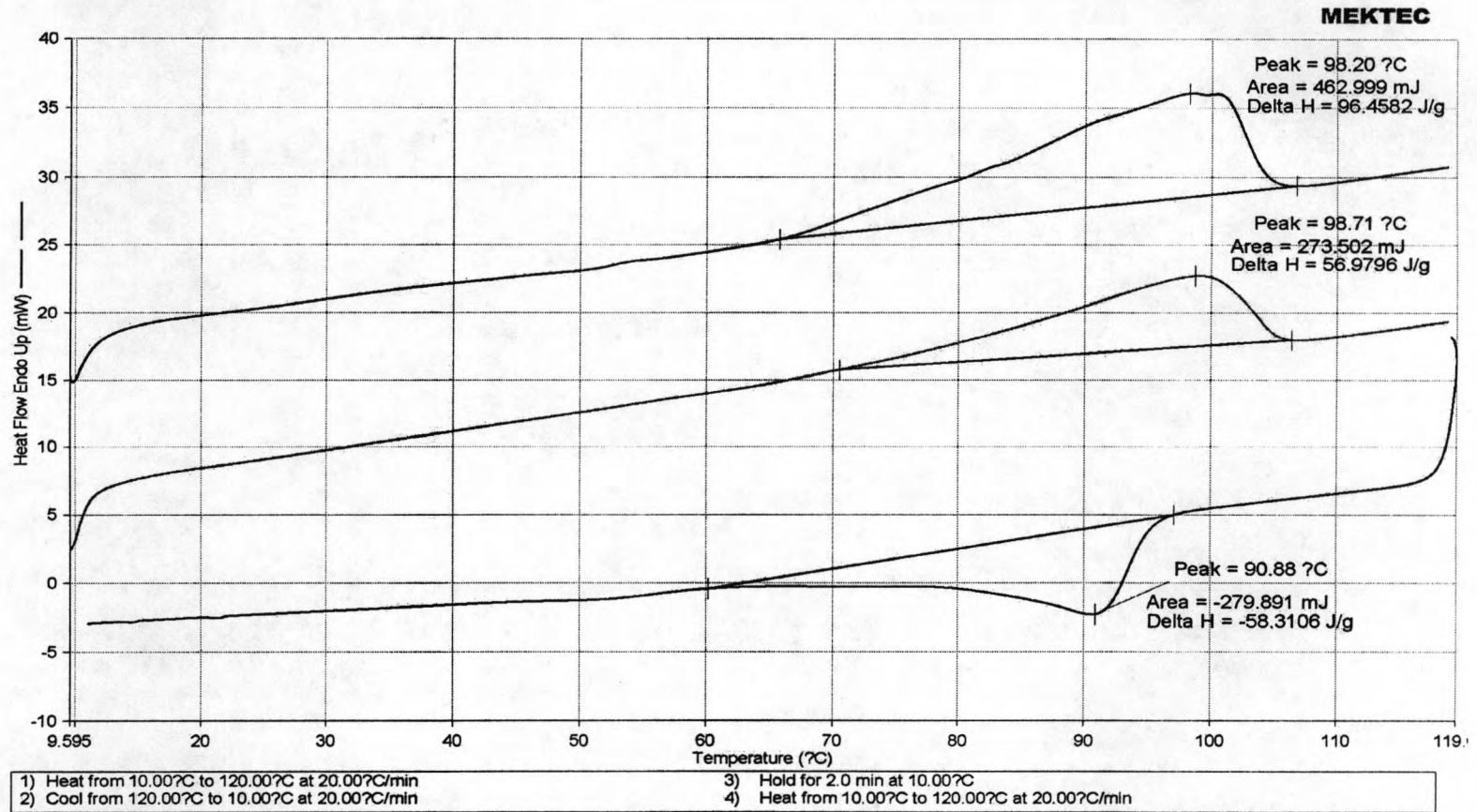


Figure A-5. DSC curve of LLDPE-nanocomposites with 0.2g of nano-Alumina ( fixed ratio of Al/Zr)

Sample ID: 0.3 Al 1135  
Sample Weight: 5.000 mg

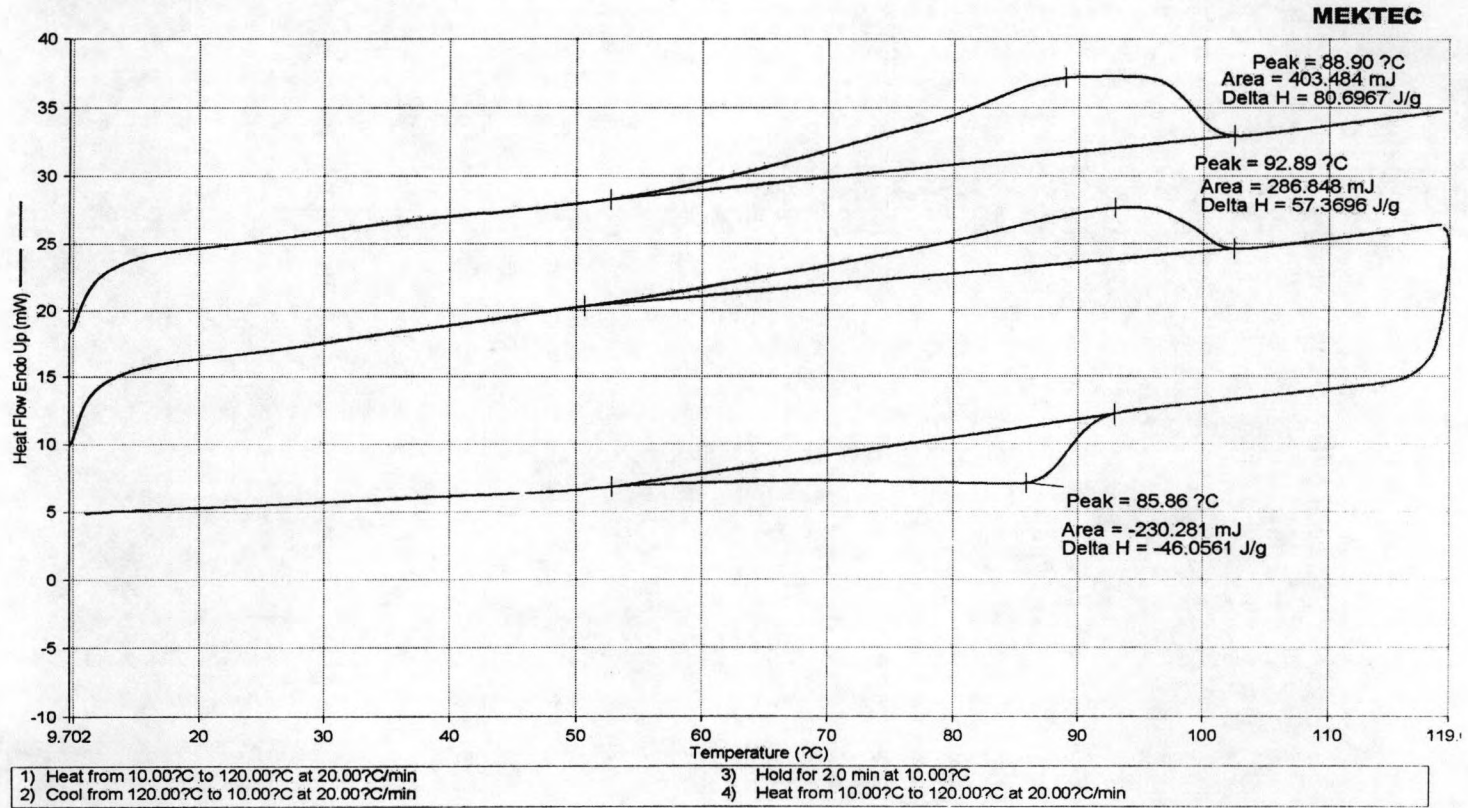
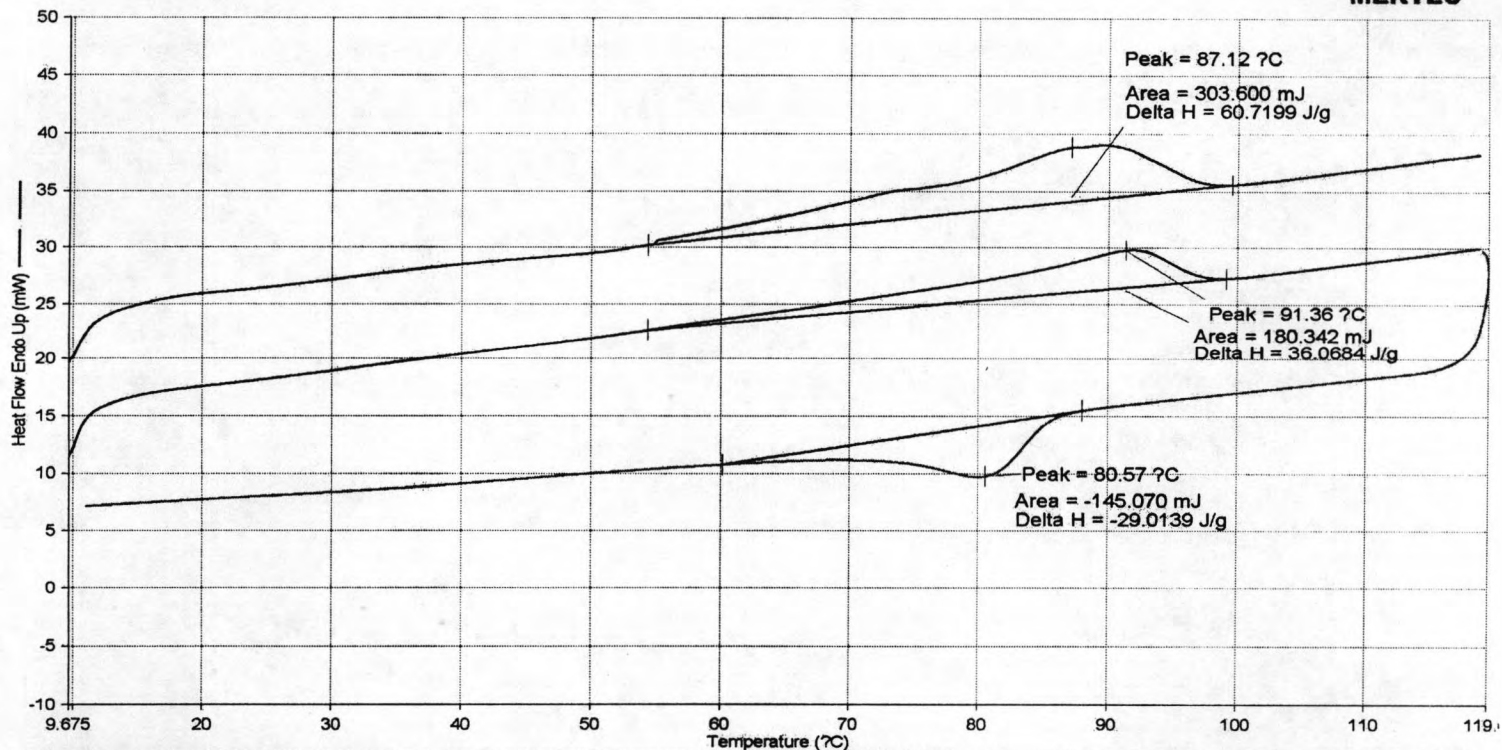


Figure A-6. DSC curve of LLDPE-nanocomposites with 0.3 g of nano Alumina ( fixed ratio of Al/Zr)

Sample ID: 0.3 Si 3405  
Sample Weight: 5.000 mg

MEKTEC



1) Heat from 10.00°C to 120.00°C at 20.00°C/min  
2) Cool from 120.00°C to 10.00°C at 20.00°C/min  
3) Hold for 2.0 min at 10.00°C  
4) Heat from 10.00°C to 120.00°C at 20.00°C/min

Figure A-7. DSC curve of LLDPE-nanocomposites with 0.3 g of nano-silica



Sample ID: 0.3 Zn 3405  
Sample Weight: 11.900 mg

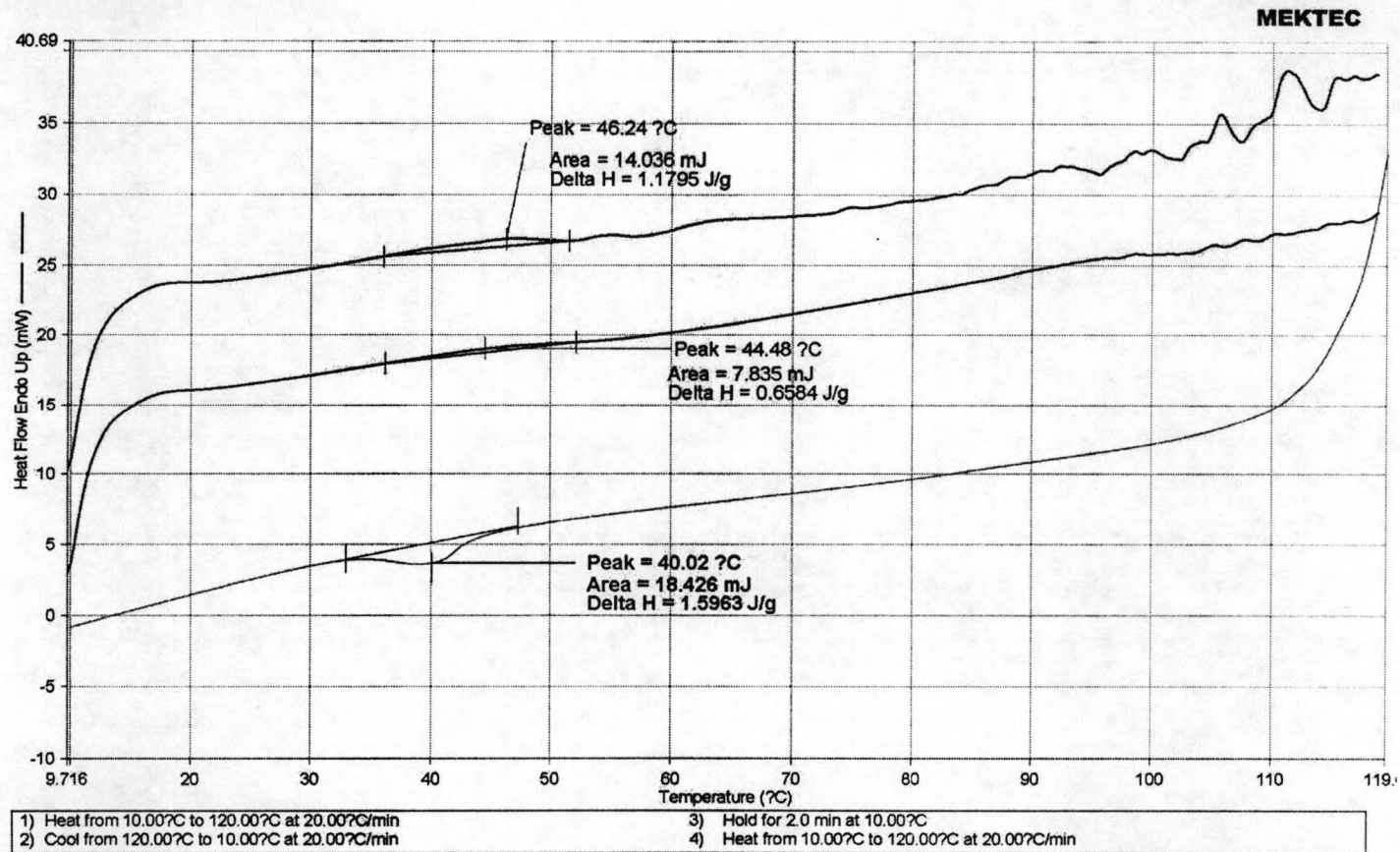


Figure A-8. DSC curve of LLDPE-nanocomposites with 0.3 g of nano-ZnO

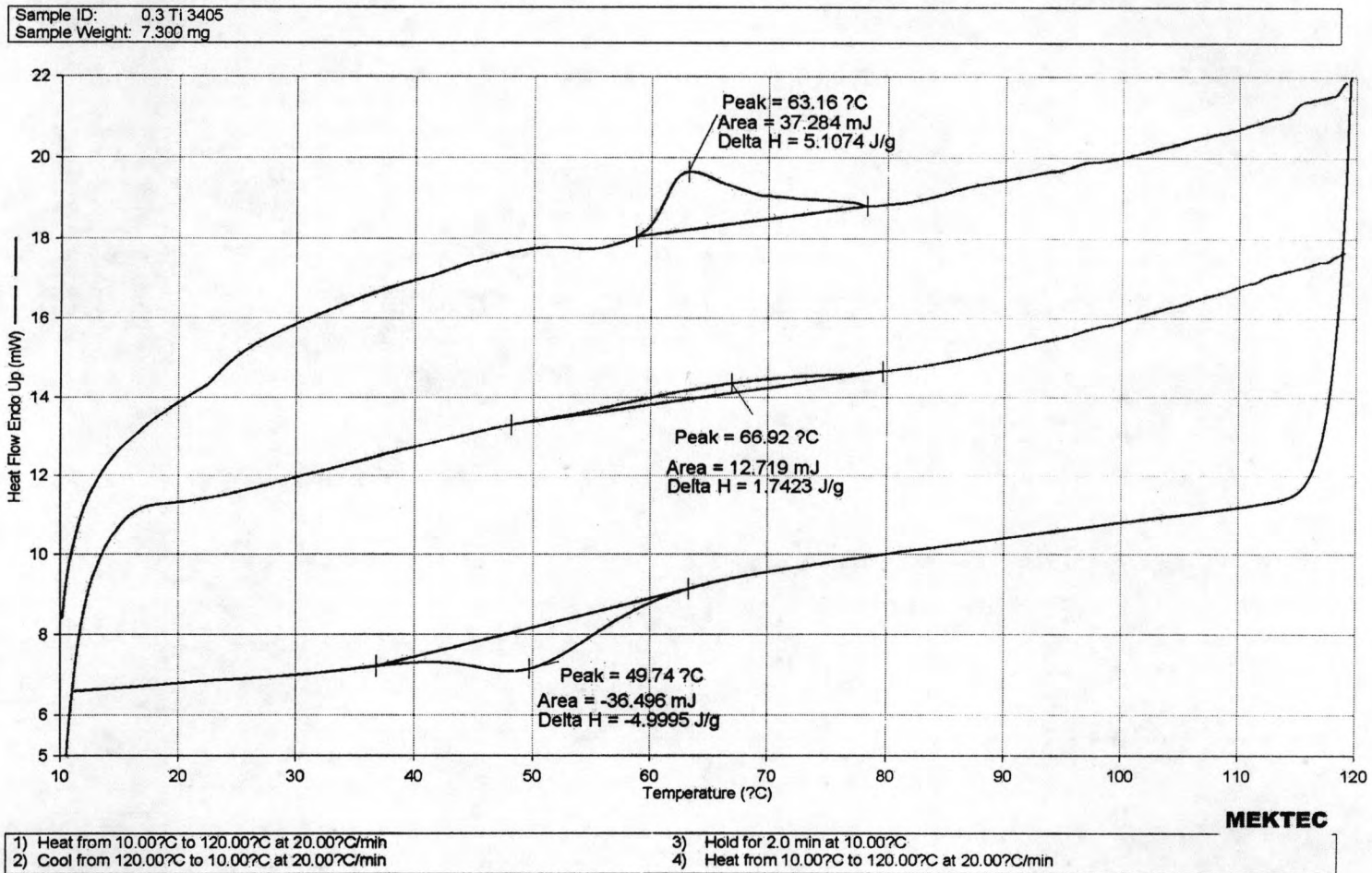


Figure A-9. DSC curve of LLDPE-nanocomposites with 0.3 g of nano-TiO<sub>2</sub>

## **APPENDIX B**

### **Nuclear Magnetic Resonance**

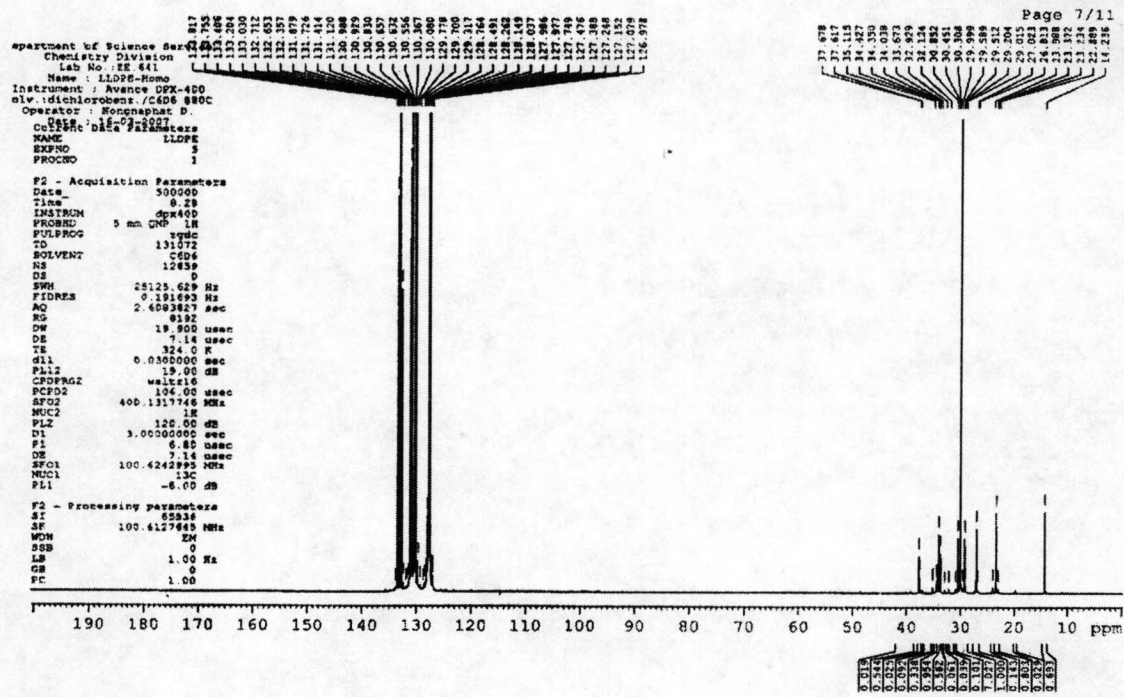


Figure B-1. <sup>13</sup>C-NMR spectrum of LLDPE with 1-hexene

Department of Science Service  
 Chemistry Division  
 Lab No.: EE.638  
 Name : LLDPE-A120310.1/1135  
 Instrument : Avance DPX-400  
 Solv. : dichlorobenz./C6D6 80:20  
 Operator : Mongnaphat D.  
 Date : 16-03-2007

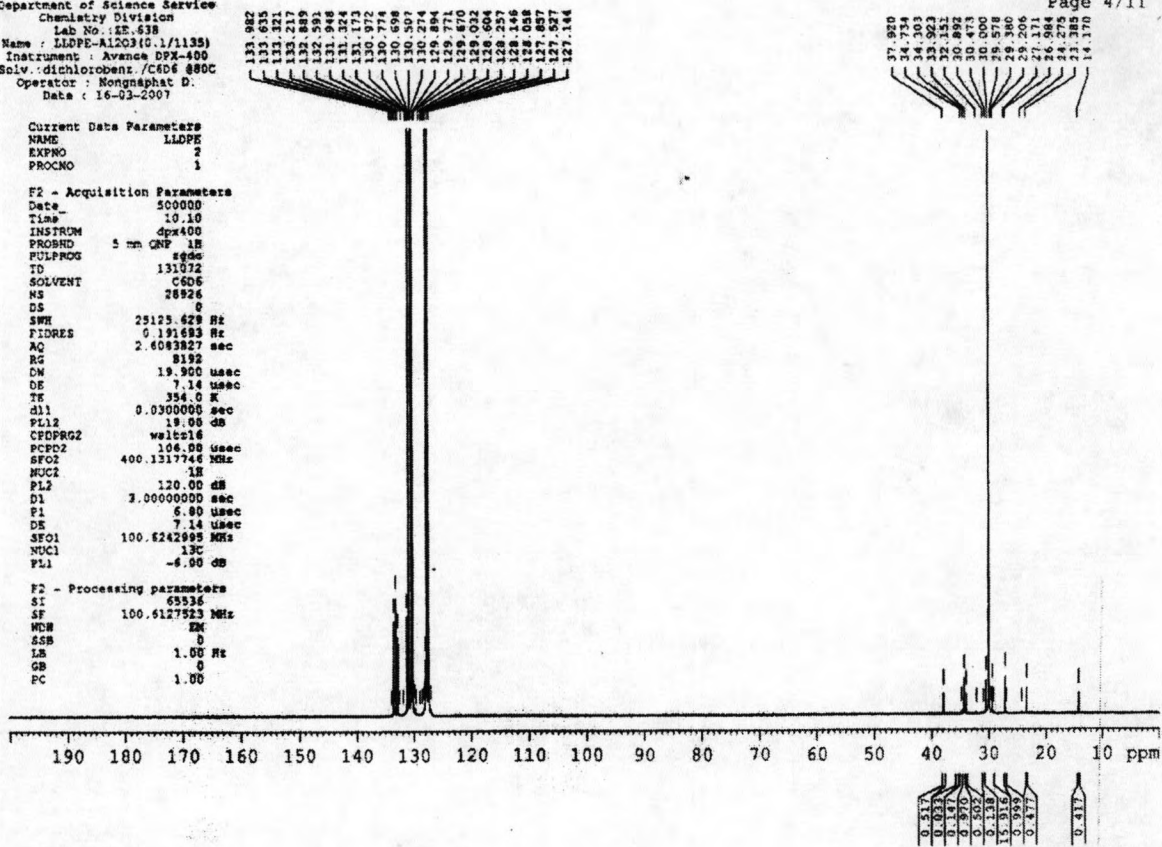


Figure B-2. <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.1g of nano-Alumina





Department of Science Service  
 Chemistry Division  
 Lab No.: ZE. 640  
 Name : LLDPE-Al2O3 (0.3/9400)  
 Instrument : Avance DMX-400  
 Solv.: dichlorobenz / C6D6 @80C  
 Operator : Nongnaphat D.  
 Date : 16-03-2007

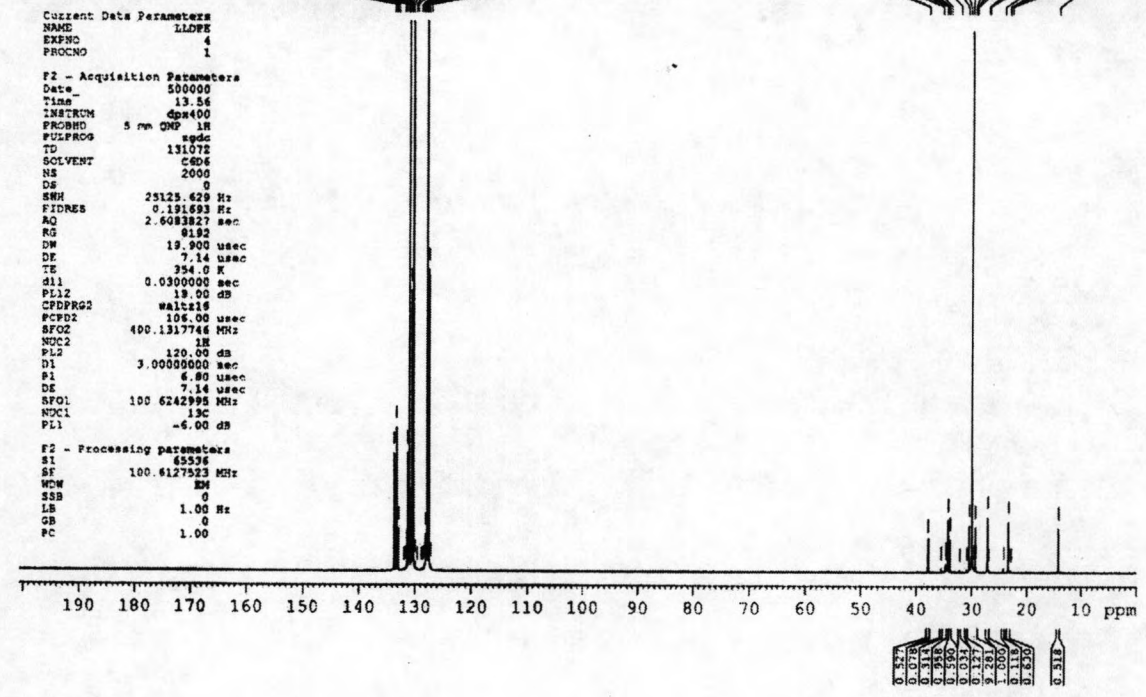


Figure B-4. <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.3 g of nano-Alumina



Department of Science Service  
 Chemistry Division  
 Lab No.: 22 439  
 Name : LLDPE-Al<sub>2</sub>O<sub>3</sub>10 3/1135  
 Instrument : Avance DPX-400  
 Solv.: dichlorobenz./C6D6 880C  
 Operator : Nongnaphat D.  
 Date : 16-03-2007

Current Data Parameters  
 NAME LLDPE  
 EXPNO 3  
 PROCNO 1

F2 - Acquisition Parameters  
 Date\_ 500000  
 Time 12.11  
 INSTRUM dpx400  
 PRCBND 5 mm QNP 1H  
 PULPROG zgpg30  
 TD 131072  
 SOLVENT C6D6  
 NS 2500  
 DS 0  
 SWH 25125.629 Hz  
 FIDRES 0.191683 Hz  
 AQ 2.6083827 sec  
 RG 8192  
 DW 19.900 usec  
 DE 7.14 usec  
 TE 354.0 K  
 d11 0.030000 sec  
 FL12 19.00 dB  
 CPDPRG2 waltz16  
 PCPD2 106.00 usec  
 SFO2 400.1317748 MHz  
 NUQ2 1H  
 PL2 170.00 dB  
 DI 3.0000000 sec  
 F1 6.00 usec  
 DE 7.14 usec  
 SFO1 100.6242988 MHz  
 NUQ1 13C  
 FL1 -6.00 dB

F2 - Processing parameters  
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 WHW 0  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 1.00

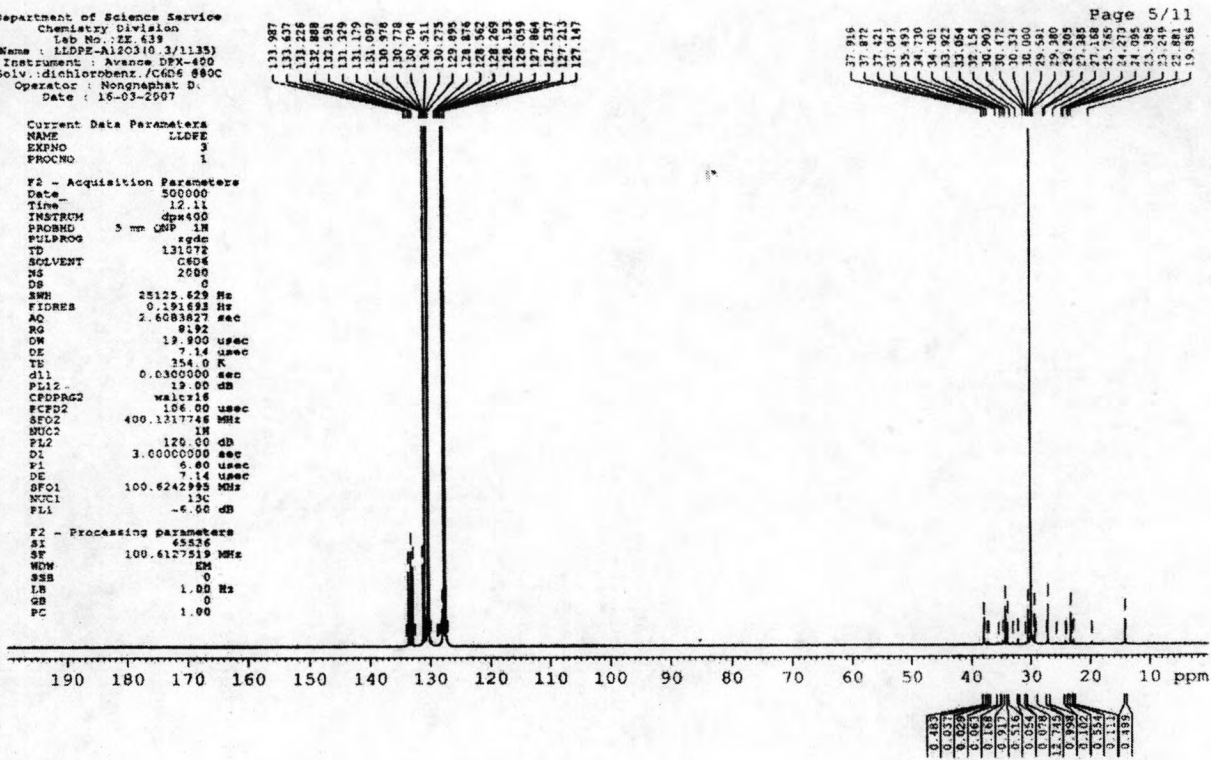


Figure B-6. <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.3 g of nano-Alumina fixed [Al]<sub>d</sub>-MMAO / [Zr] = 1135

Department of Science Service  
 Chemistry Division  
 Lab No. : 2C.443  
 Name : LLDPE-3102  
 Instrument : Avance DPX-400  
 Solv : dichlorobenz./CDCl<sub>3</sub>  
 Operator : Nonnaphat D.  
 Date : 16-01-2007

Current Data Parameters  
 NAME LLDPE  
 EXPNO 7  
 PROCNO 1

F2 - Acquisition Parameters  
 Date\_ 500000  
 Time 16.12  
 INSTRUM dpx400  
 PROBRD 5 mm QNP 1H  
 POLPRG2 zgpg30  
 TD 131072  
 SOLVENT CDCl<sub>3</sub>  
 NS 3000  
 DS 0  
 SWH 25125.629 KHz  
 FIDRES 0.181593 KHz  
 AQ 2.4083627 sec  
 RG 8192  
 CW 19.900 usec  
 DE 7.14 usec  
 TE 394.0 K  
 S11 0.0300000 sec  
 FLL2 19.00 dB  
 CPDPRG2 waltz16  
 PCPD2 106.00 usec  
 STC2 400.121746 MHz  
 NU02 1H  
 FL2 120.00 dB  
 F1 3.00000000 sec  
 F1 6.80 usec  
 STC1 100.6242995 MHz  
 NU01 13C  
 F11 -6.00 dB

F2 - Processing parameters  
 SI 62836  
 SF 100.6127530 MHz  
 WDM EM  
 SSB 0  
 LB 1.00 KHz  
 GB 0  
 PC 1.00

133.948  
133.611  
133.453  
133.455  
132.556  
131.311  
131.166  
130.778  
130.702  
130.505  
130.258  
129.879  
128.583  
128.274  
128.183  
128.099  
127.842  
127.542  
127.237  
127.138  
126.752  
126.096

37.905  
34.726  
34.287  
33.817  
31.431  
30.006  
29.574  
29.373  
27.038  
23.383  
14.178

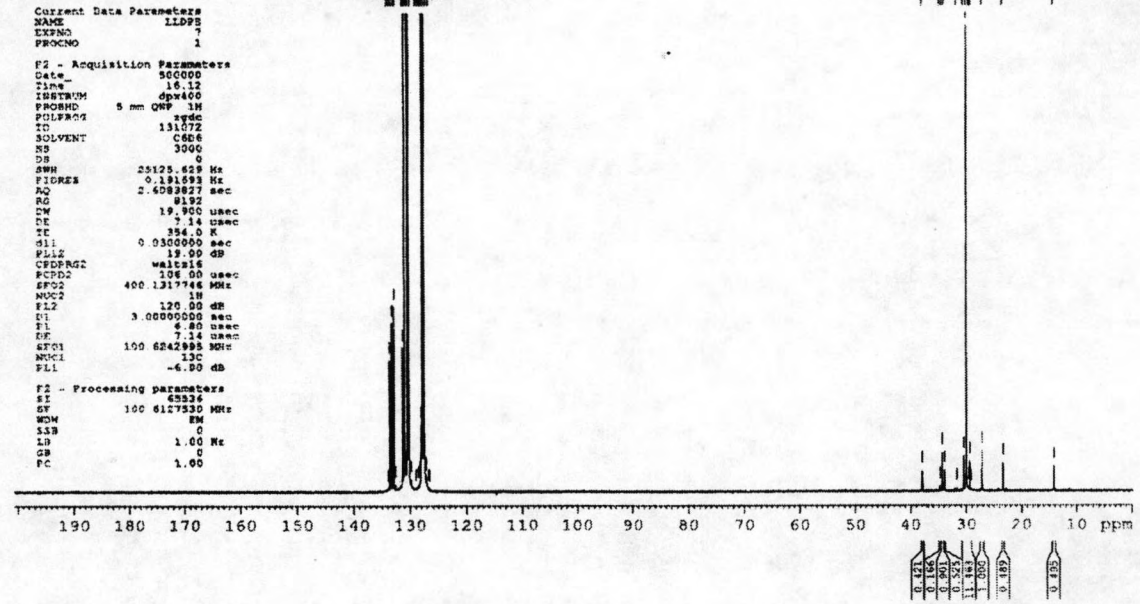


Figure B-7. <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.3g of nano-Silica



Department of Science Services  
 Chemistry Division  
 Lab No.: SE 642  
 Name : LLDPE-ZnO  
 Instrument : Avance DPX-400  
 solv. dichlorobenz /C6D6 80C  
 Operator : Nongnaphet D.  
 Date : 16-03-2007

Current Data Parameters  
 NAME LLDPE  
 EXPNO 4  
 PROCNO 1

F2 - Acquisition Parameters  
 Date\_ 20070316  
 Time 11:44  
 INSTRUM dpx400  
 PROBHD 5 mm QNP 1H  
 PULPROG zgpg30  
 TD 131072  
 SOLVENT C6D6  
 NS 13004  
 DS 0  
 SWH 25125.629 Hz  
 FIDRES 0.191693 Hz  
 AQ 2.6083827 sec  
 RG 6192  
 DM 19.900 usec  
 DE 7.14 usec  
 TE 354.0 K  
 d11 0.0300000 sec  
 FL12 19.00 dB  
 CPDPRG2 waltz16  
 PCPD2 126.00 usec  
 SFO2 400.1317746 MHz  
 NUCC2 1H  
 FL2 120.00 dB  
 D1 3.00000000 sec  
 F1 5.80 usec  
 DE 7.14 usec  
 SFO1 100.6242885 MHz  
 NUC1 13C  
 FL1 -6.00 dB

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 MW 64  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 EC 1.00

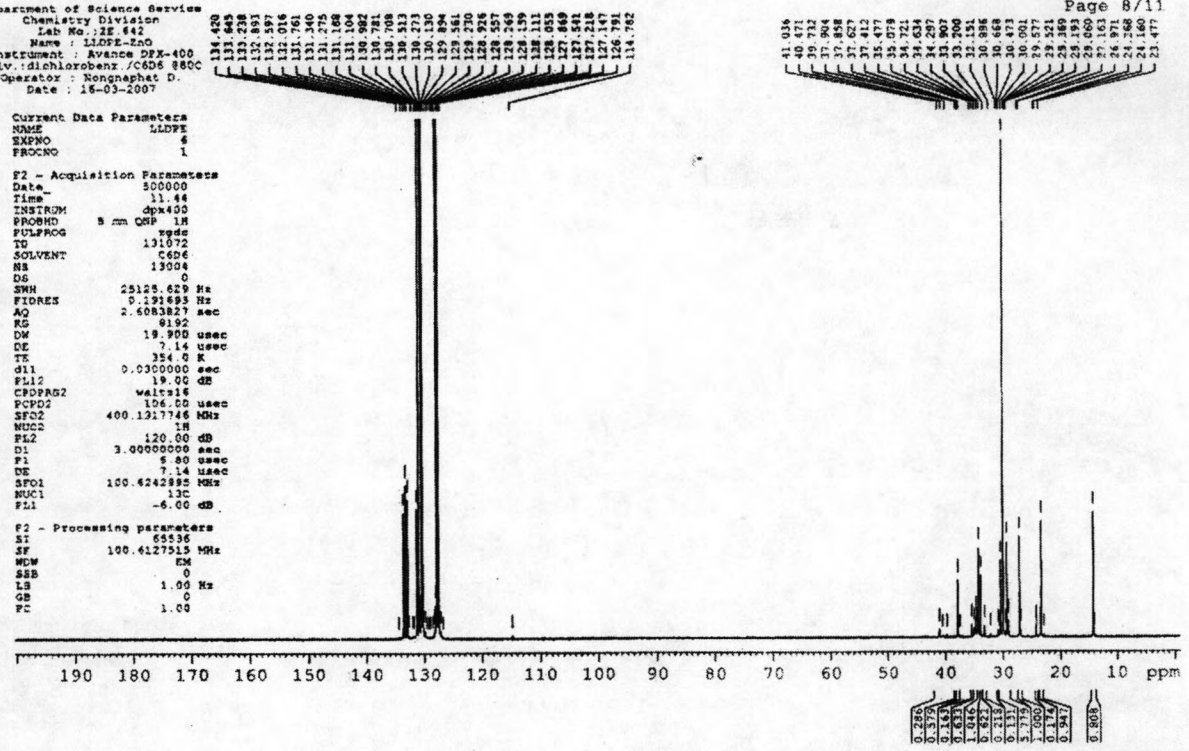


Figure B-8 <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.3g of nano-ZnO

Department of Science Service  
 Chemistry Division  
 Lab No.: 2E.644  
 Name: LLDPE-TiO2  
 Instrument: Avance DFX-400  
 Solv.: dichlorobenz./CDCl3 @90C  
 Operator: Nongnaphat D.  
 Date: 15-03-2007

Current Data Parameters  
 NAME LLDPE  
 EXPNO 8  
 PROCNO 1

F2 - Acquisition Parameters  
 Date\_ 500000  
 Time 17.14  
 INSTRUM dpa400  
 PROBRD 5 mm QNP 1H  
 PULPROG zgpg30  
 TD 131072  
 SOLVENT CDCl3  
 NS 2000  
 DS 0  
 SWH 25123.629 Hz  
 FIDRES 0.191693 Hz  
 AQ 2.6083827 sec  
 RG 8192  
 CW 19.900 usec  
 DE 7.14 usec  
 TE 354.0 K  
 G11 0.0300000 sec  
 F112 19.00 dB  
 CPDPRG2 waltrix  
 PCPD1 106.00 usec  
 SFO1 400.1317746 MHz  
 NUC2 1H  
 PL2 120.00 dB  
 D1 3.0000000 sec  
 F1 6.00 usec  
 DE 7.14 usec  
 SFO1 100.6242995 MHz  
 NUCL 13C  
 PL1 -6.00 dB

F2 - Processing parameters  
 SI 65536  
 SF 100.6127526 MHz  
 WDM EM  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 1.00

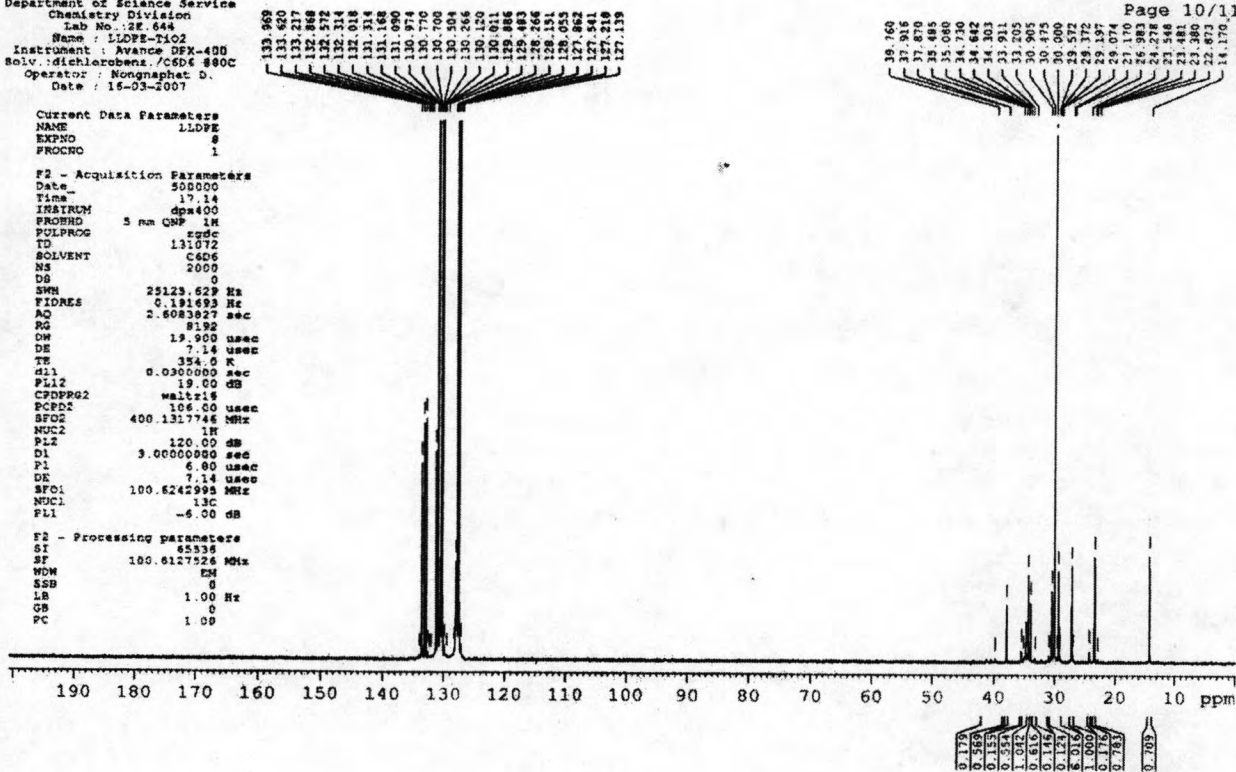
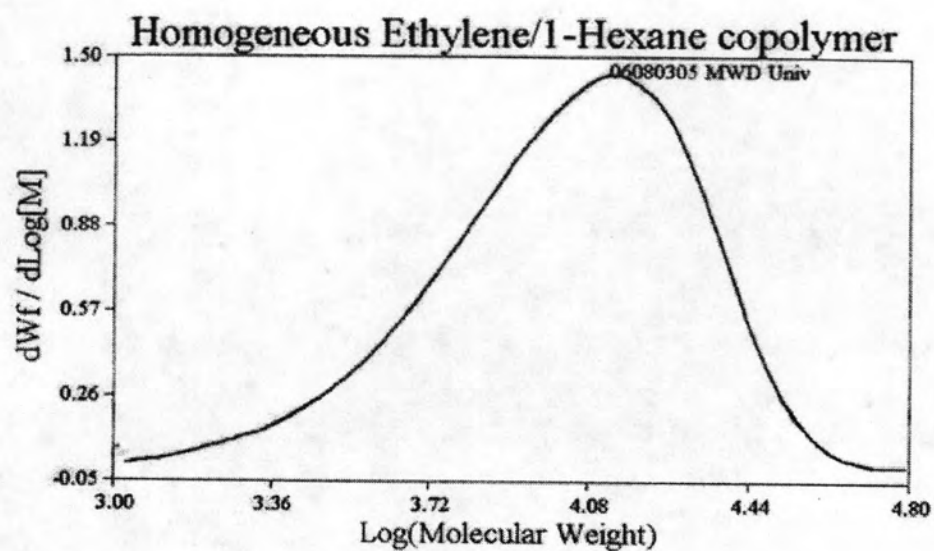


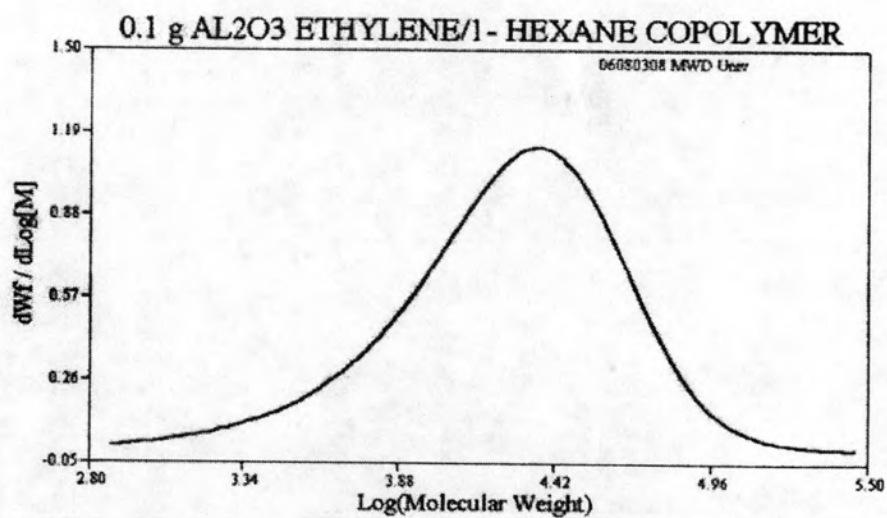
Figure B-9 <sup>13</sup>C-NMR spectrum of LLDPE-nanocomposites with 0.3g of nano-Titania

**APPENDIX C**

**Gel Permeation Chromatography**



**Figure C-1** : GPC curve of LLDPE homogeneous system  $[Al]_{d-MMAO}/[Zr]_{cat}=1135$



**Figure C-2** : GPC curve of LLDPE/nano-alumina composite at  $[Al]_{d-MMAO}/[Zr]_{cat}=2270$ , catalyst precursor= 0.1 g

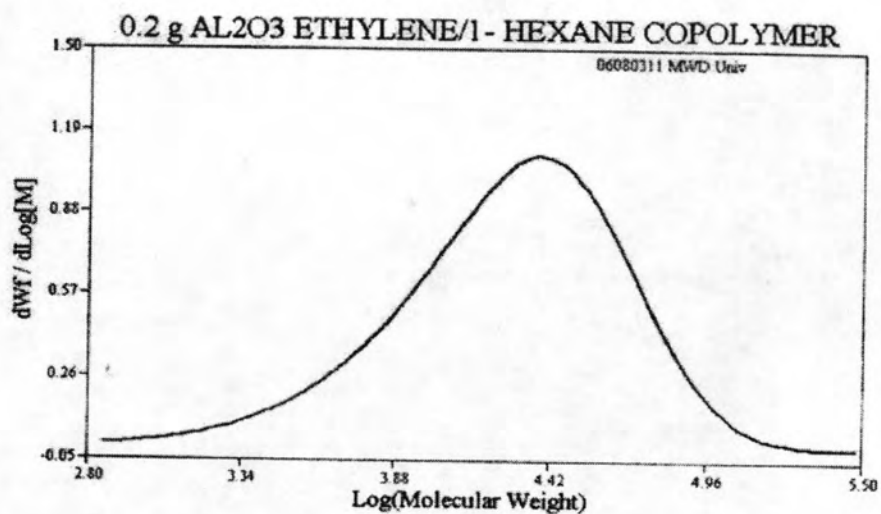


Figure C-3 : GPC curve of LLDPE/nano-alumina composite at  $[Al]_{d-MMAO}/[Zr]_{cat}=2270$ , catalyst precursor= 0.2 g

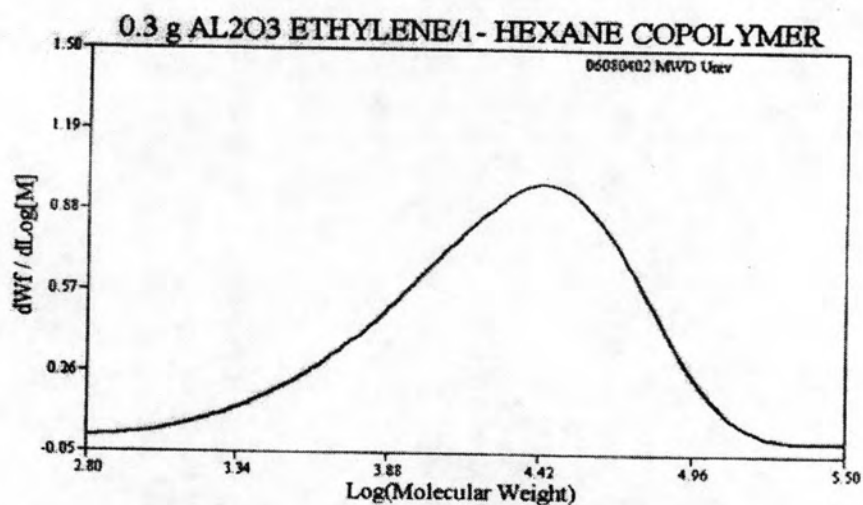
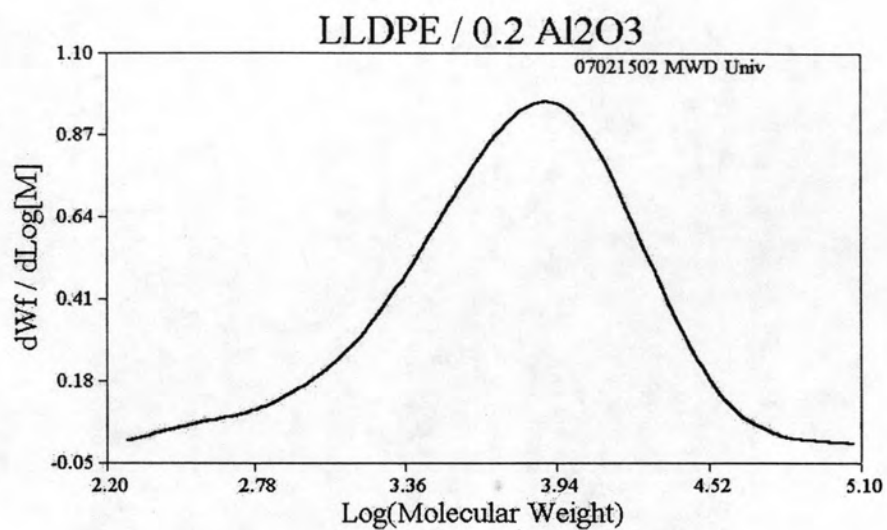
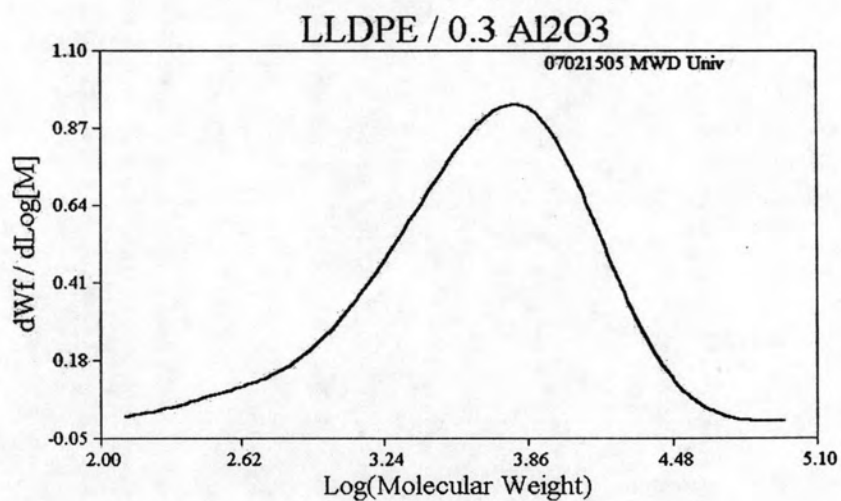


Figure C-4 : GPC curve of LLDPE/nano-alumina composite at  $[Al]_{d-MMAO}/[Zr]_{cat}=3405$ , catalyst precursor= 0.3 g





**Figure C-5** : GPC curve of LLDPE/nano-alumina composite at  $[Al]_{d-MMAO}/[Zr]_{cat}=1135$ , catalyst precursor= 0.2 g



**Figure C-6** : GPC curve of LLDPE/nano-alumina composite at  $[Al]_{d-MMAO}/[Zr]_{cat}=1135$ , catalyst precursor= 0.3 g

## **APPENDIX D**

### **Calculation of polymer properties**

### Calculation of polymer microstructure

Polymer microstructure and also triad distribution of monomer can be calculated according to the Prof. James C. Randall as literature 73 in the list of reference. The detail of calculation was be interpreted as follow

#### Ethylene/1-hexene copolymer

The integral area of  $^{13}\text{C}$ -NMR spectrum in the specify rage are listed.

$T_A$	=	39.5-42	ppm
$T_B$	=	38.1	ppm
$T_C$	=	33-36	ppm
$T_D$	=	26.5-27.5	ppm
$T_F$	=	24-25	ppm
$T_G$	=	23.4	ppm
$T_H$	=	14.1	ppm

Triad distribution was calculated as the followed formular

$$\begin{aligned}
 k[\text{HHH}] &= 2T_A - T_C + T_G + 2T_F + T_E \\
 k[\text{EHH}] &= 2T_C - 2T_G - 4T_F - 2T_E - 2T_A \\
 k[\text{EHE}] &= T_B \\
 k[\text{EEE}] &= 0.5T_E - 0.5T_G - 0.25T_E \\
 k[\text{HEE}] &= T_E \\
 k[\text{HEH}] &= T_F
 \end{aligned}$$

### Calculation of crystallinity for ethylene/1-olefin copolymer

The crystallinities of copolymers were determined by differential scanning calorimeter. % crystallynity of copolymers is calculated from equation.

$$\%Crystallinity = \frac{\Delta H_m}{\Delta H_m^o} \times 100$$

Where  $\Delta H_m$  = the heat of fusion of sample (J/g)

$\Delta H_m$  = the heat of fusion of perfectly crystalline polyethylene

= 286 J/g

## **APPENDIX E**

### **The specification of commercial nano-materials**

**Aluminum oxide nanopowder**

Aldrich	
Synonym	Alumina
Molecular Formula	Al <sub>2</sub> O <sub>3</sub>
Molecular Weight	101.96
CAS Number	1344-28-1
EG/EC Number	2156916
MDL number	MFCD00003424

**Properties**

description	gamma phase
form	nanopowder
particle size	40-47 nm
surface area	35-43 m <sup>2</sup> /g
mp	2040 °C(lit.)

**References**

Merck	<i>Merck 13,35</i>
Fieser	<i>Fieser 1,19 / Fieser 2,17 / Fieser 3,6 / Fieser 4,8 / Fieser 6,16 / Fieser 7,5 / Fieser 8,9 / Fieser 9,8 / Fieser 10,8 / Fieser 11,22 / Fieser 13,14 / Fieser 14,20 / Fieser 16,9</i>
reference	<i>Corp MSDS 1 (1), 115:A / RegBook 1 (3), 3273:J / RegBook 1 (3), 3533:A / Sax 6, 178</i>

**Safety**

WGK Germany	-
RTECS	BD1200000
F	3



**Nano-SiO<sub>2</sub> 15 nm, 99.5%**

Aldrich	Silica
Molecular Formula	SiO <sub>2</sub>
Molecular Weight	60.08

**Properties**

surface area BET surf. area	140-180 m <sup>2</sup> /g
bp	>100 °C(lit.)
	2230 °C(lit.)
Mp	>1600 °C(lit.)
density	2.2-2.6 g/mL at 25 °C
bulk density	.011 g/mL

**References**

Merck	Merck 13,8567
Reference	Corp MSDS 1 (2), 3090:A / RegBook 1 (3), 3535:B / Sax 6, 2395

**Safety**

Safety Statements 22-24/25

WGK	Germany 2
RTECS	VV7310000

**Zinc oxide nanopowder**

Aldrich	
Molecular Formula	ZnO
Molecular Weight	81.39
CAS Number	1314-13-2
EG/EC Number	2152225
MDL number	MFCD00011300

**Properties**

Form	nanopowder
Surface area	15-25 m <sup>2</sup> /g
Particles size	50-70 nm

**References**

Cited References	1. Healey, A.M. et al. <i>Inorg. Chem.</i> <b>38</b> , 455, (1999)
Merck	<i>Merck</i> <b>13</b> ,10200
Fieser	<i>Fieser</i> <b>1</b> ,1294 / <i>Fieser</i> <b>5</b> ,622
reference	<i>Corp MSDS</i> <b>1</b> (2), 3631:C / <i>RegBook</i> <b>1</b> (3), 3281:C / <i>Sax</i> <b>6</b> , 2755

**Safety**

Hazard Codes	N
Risk Statements	50/53
Safety Statements	60-61
RIDADR	UN 3077 9/PG 3
WGK Germany	2
RTECS	ZH4810000

**Titanium(IV) oxide nanopowder, doped with 1% Mn, 97+ %**

Aldrich	
Synonym	Titania Titanium dioxide
Molecular Formula	TiO <sub>2</sub>
Molecular Weight	79.87
CAS Number	13463-67-7
EG/EC Number	2366755
MDL number	MFCD00011269

**Properties**

assay	97+ %
particle size	<100 nm
surface area	>14.0 m <sup>2</sup> /g
mp	>350 °C(lit.)
density	4.26 g/mL at 25 °C(lit.)
bulk density	.011 g/mL

**References**

G. Wakefield, S. Lipscomb, E. Holland, J. Knowland, The Effects of Manganese Doping on UVA Absorption and Free Radical Generation of Micronised Titanium Dioxide and Its Consequences for the Photostability of UVA Absorbing Organic Sunscreen Components *Photochem. Photobiol.* **3**, 648-652, (2004)

G. Wakefield, M. Green, S. Lipscomb, B. Flutter, Modified Titania Nanomaterials for Sunscreen Application - Reducing Free Radical Generation and DNA Damage *Mater. Sci. Technol.* **20**, 985-988, (2004)

Stone, V.F.; Davis, R.J. *Chem. Mater.* **10**, 1468, (1998)

Merck *Merck* 13,9549

**Safety**

Hazard Codes Xn



## VITA

Mr. Chanathip Desharun was born in August 7<sup>th</sup>, 1983 in Phangnga, Thailand. He finished high school from Princess Chulabhorn's college, Trang and received bachelor's degree in Engineering from the department of Chemical Engineering, Faculty of Engineering, Prince of Songkla University, Songkhla, Thailand in 2005.