

**Supporting Information**

**For**

**Kinetic and Microstructural Studies of  $\text{Cp}_2\text{ZrCl}_2$  and  $\text{Cp}_2\text{HfCl}_2$ -Catalyzed  
Oligomerization of Higher  $\alpha$ -Olefins in mPAO Oil Base Stocks Production**

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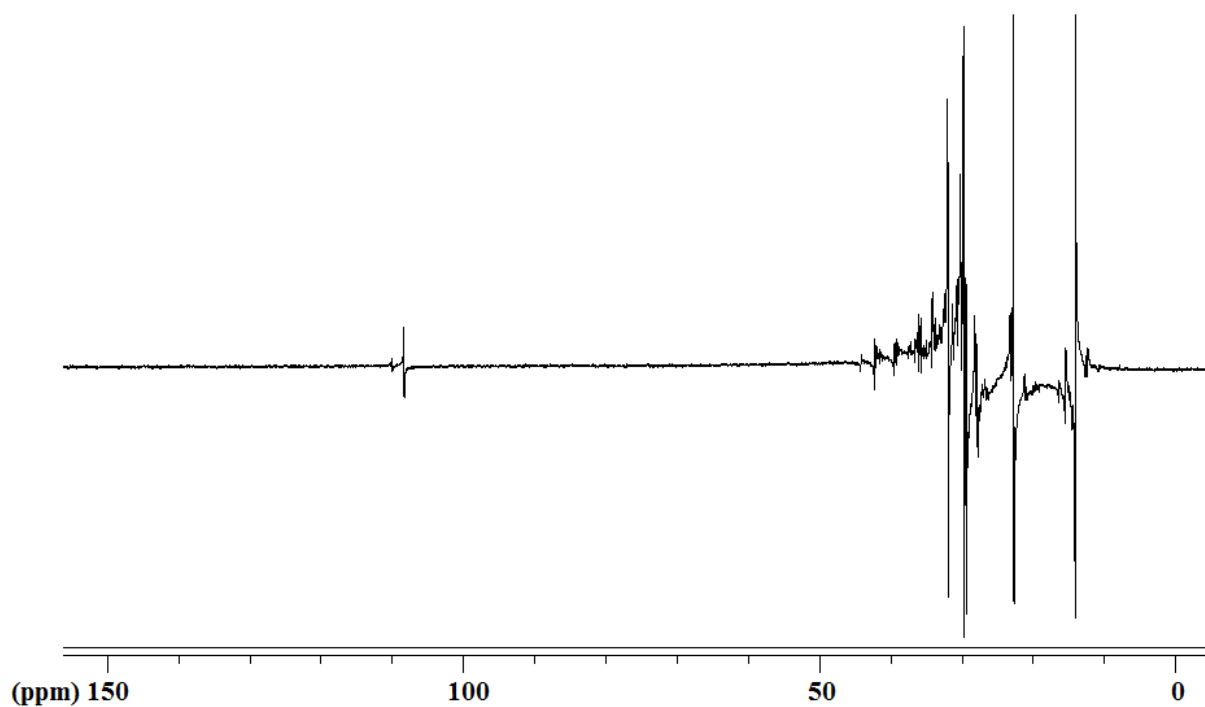


Fig S1. DEPT-135 spectrum of Zr-H sample

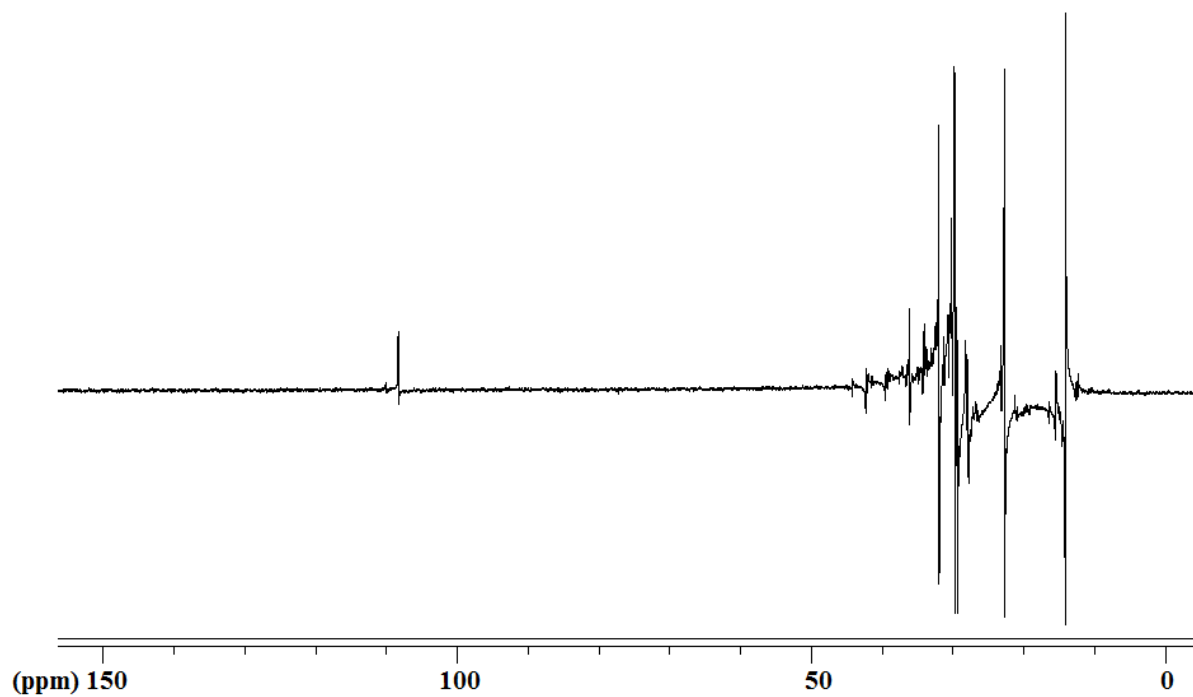


Fig S2. DEPT-135 spectrum of Zr-O sample

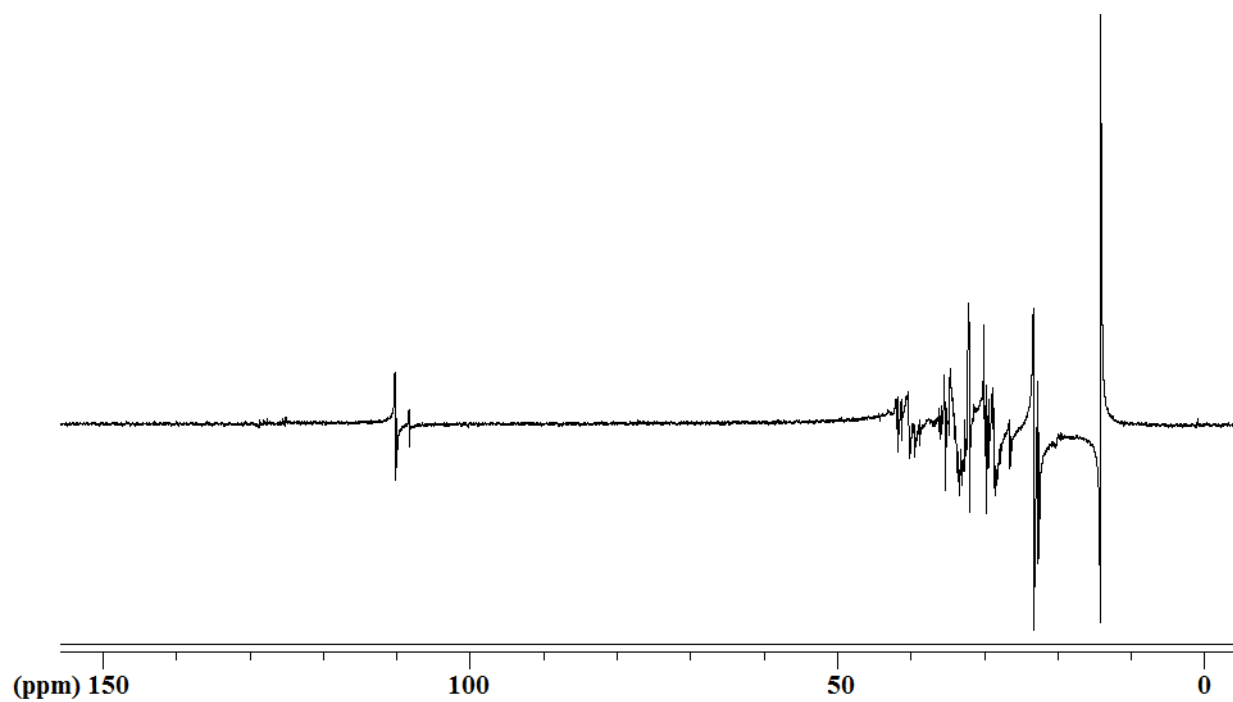


Fig S3. DEPT-135 spectrum of Hf-H sample

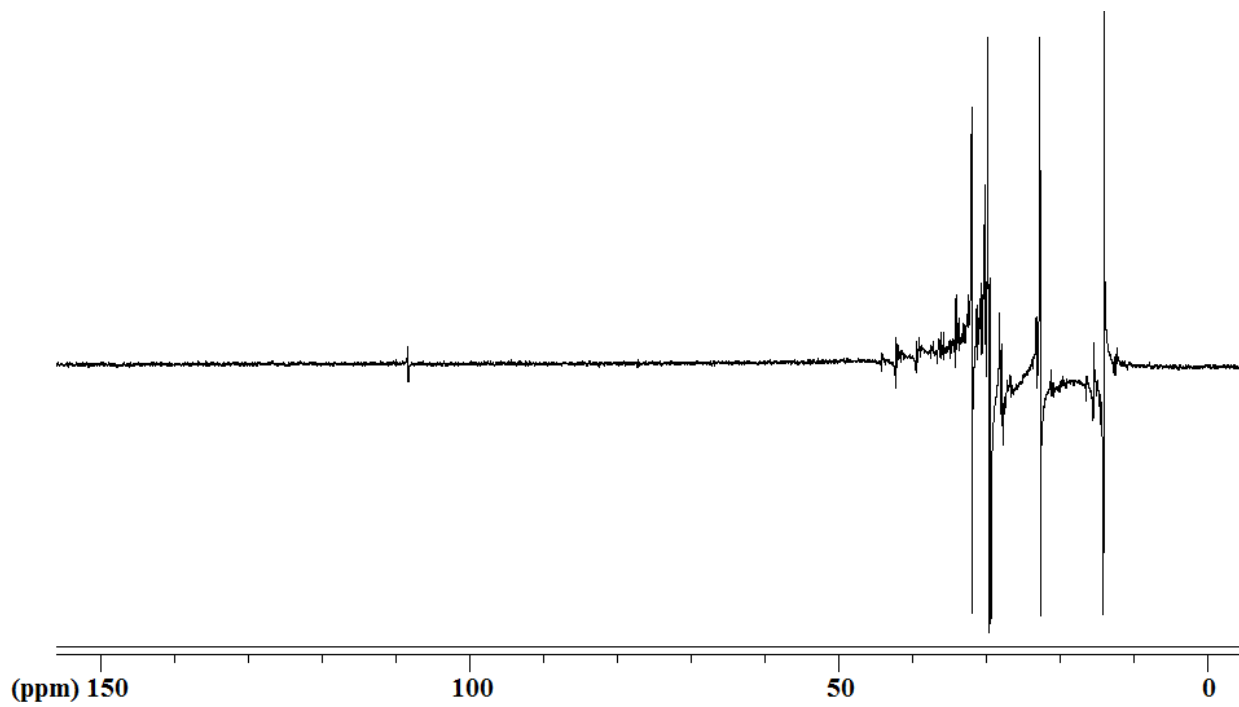


Fig S4. DEPT-135 spectrum of Hf-O sample

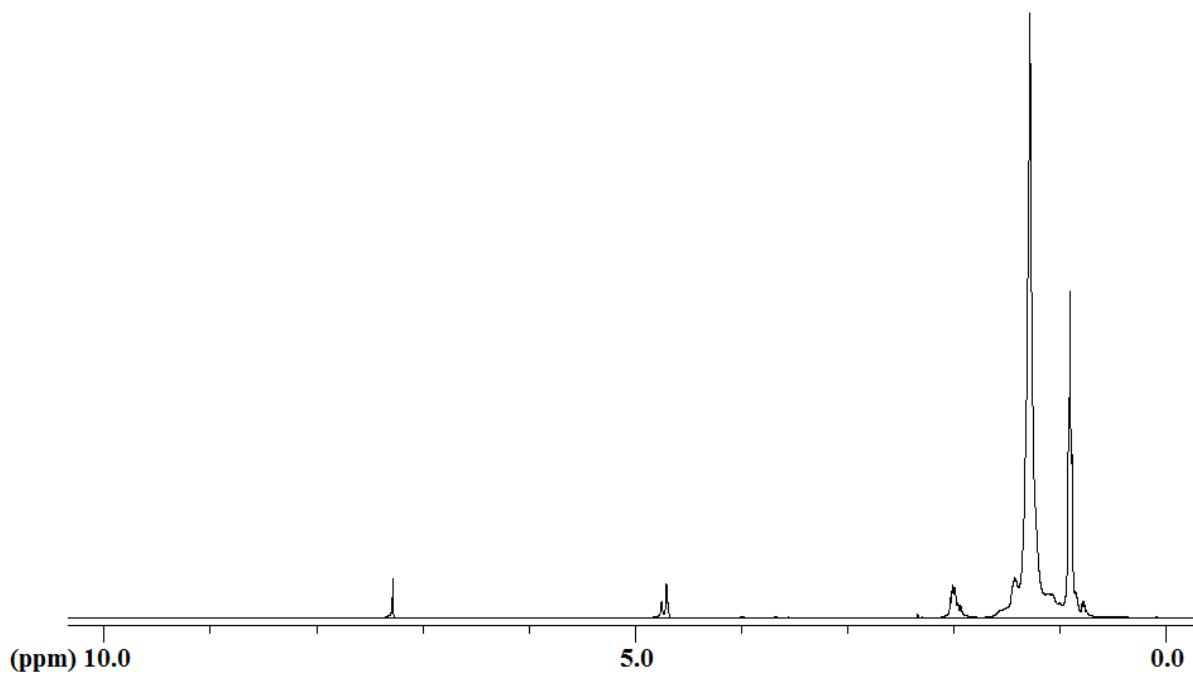


Fig S5. <sup>1</sup>H-NMR spectrum of Zr-H sample

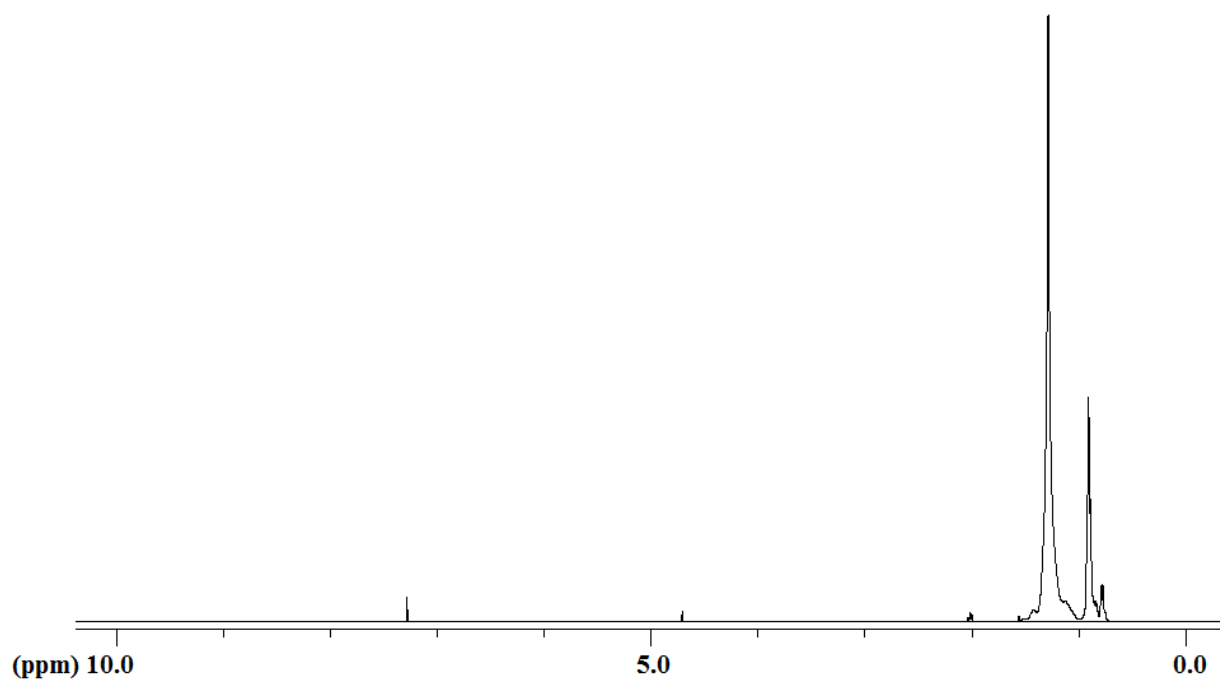


Fig S6. <sup>1</sup>H-NMR spectrum of Zr-O sample

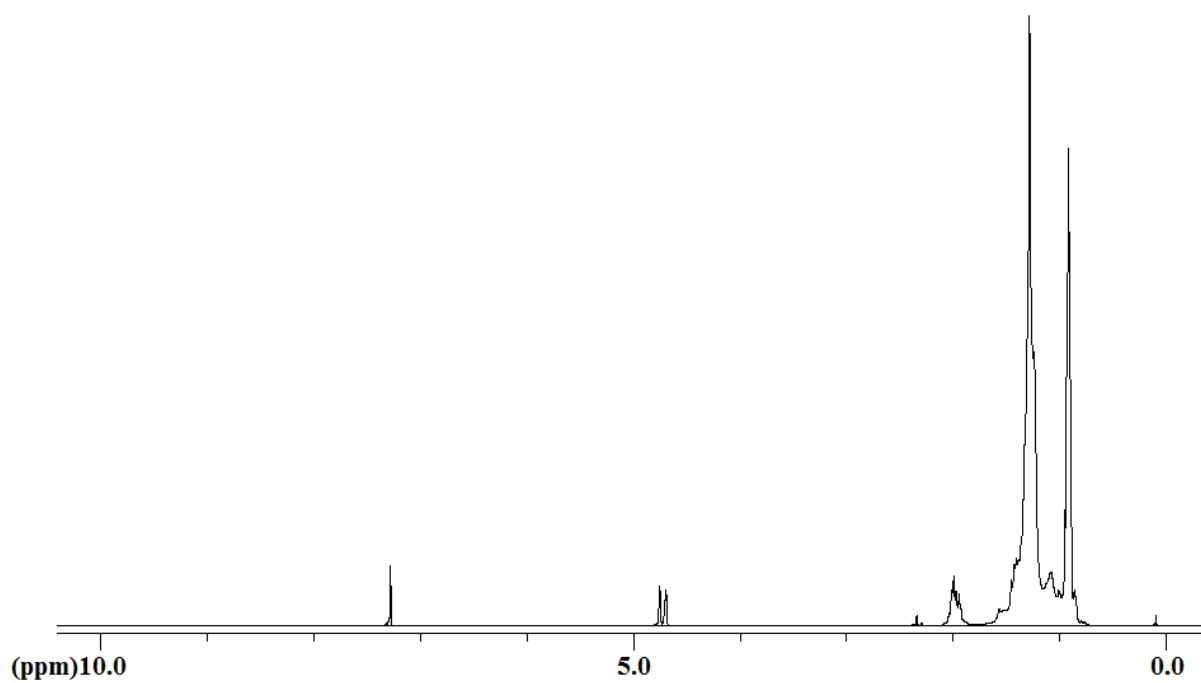


Fig S7. <sup>1</sup>H-NMR spectrum of Hf-H sample

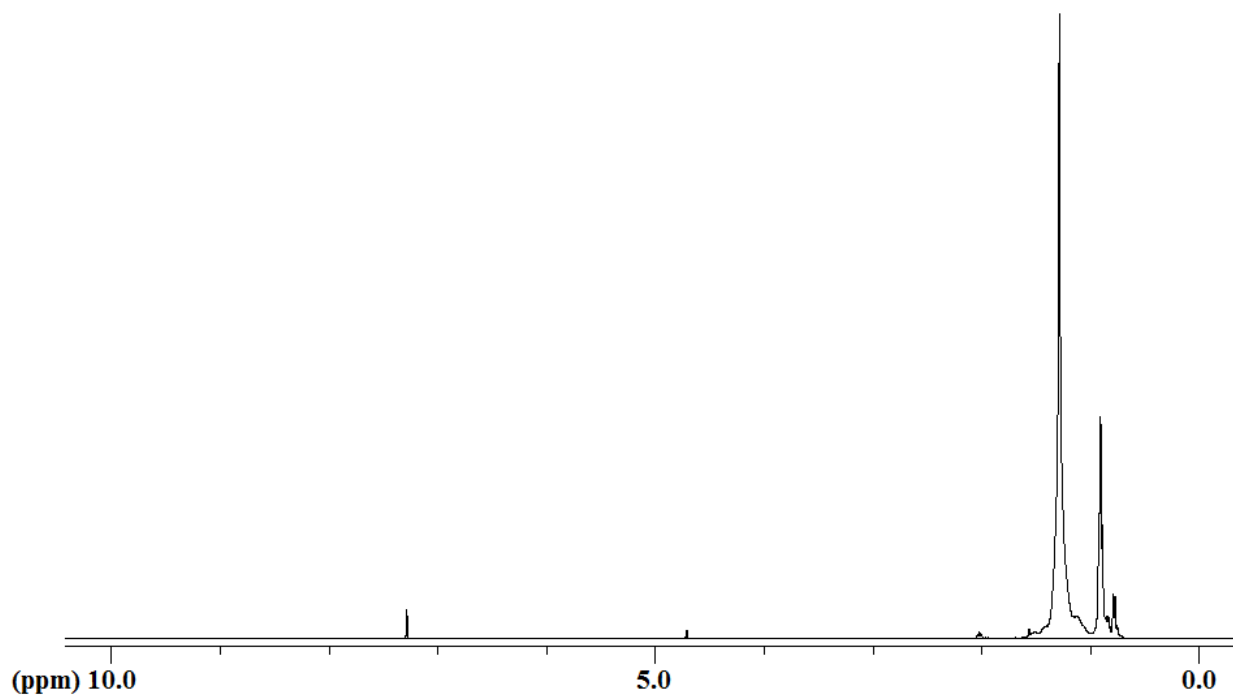
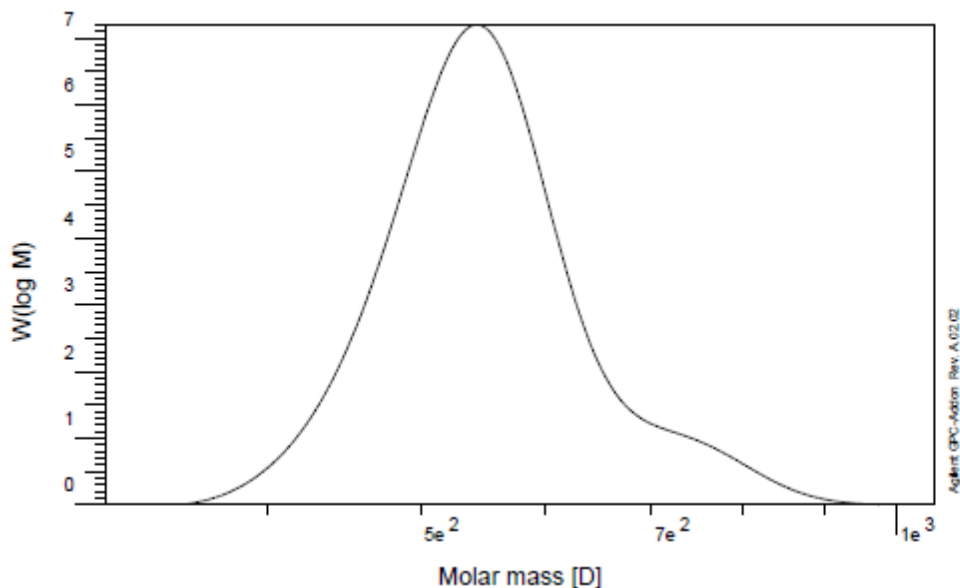


Fig S8.  $^1\text{H}$ -NMR spectrum of Hf-O sample



Sample : 6  
 Injection Date : 18-Jun-20, 08:50:56  
 Calibration File : C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
 Calibration Date : Tuesday 20/06/09 13:51:38  
 Baseline from : 17.950 min  
 Integration from : 17.950 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : PLgel OH-MIXED C  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPP1

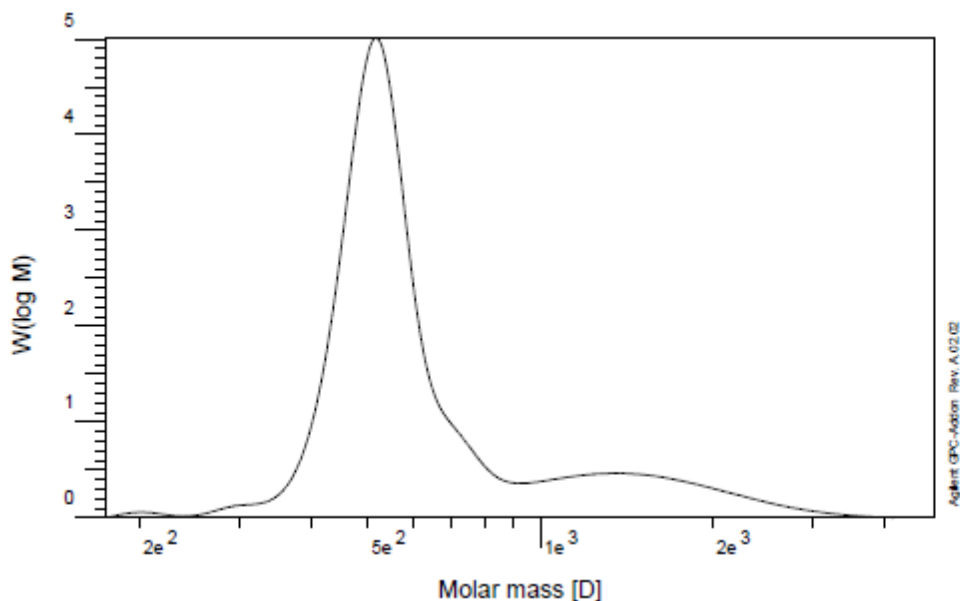
Baseline to : 19.148 min  
 Integration to : 19.148 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 29.960 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

**rid1A**

**M<sub>n</sub>** : 5.4328e2 g/mol  
**M<sub>w</sub>** : 5.5555e2 g/mol  
**M<sub>z</sub>** : 5.6900e2 g/mol  
**M<sub>v</sub>** : 0.000000 g/mol  
**D** : 1.0228e0  
**[n]** : 0.000000 ml/g  
**V<sub>p</sub>** : 1.8612e1 ml  
**M<sub>p</sub>** : 5.4254e2 g/mol  
**A** : 5.1335e3 ml<sup>3</sup>V  
 < 316 0.00  
 w% : 100.00  
 > 1058 0.00

Fig S9. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-hexene]= 0.08 mol, t=3 h,

Al/M= 500, T=80 °C

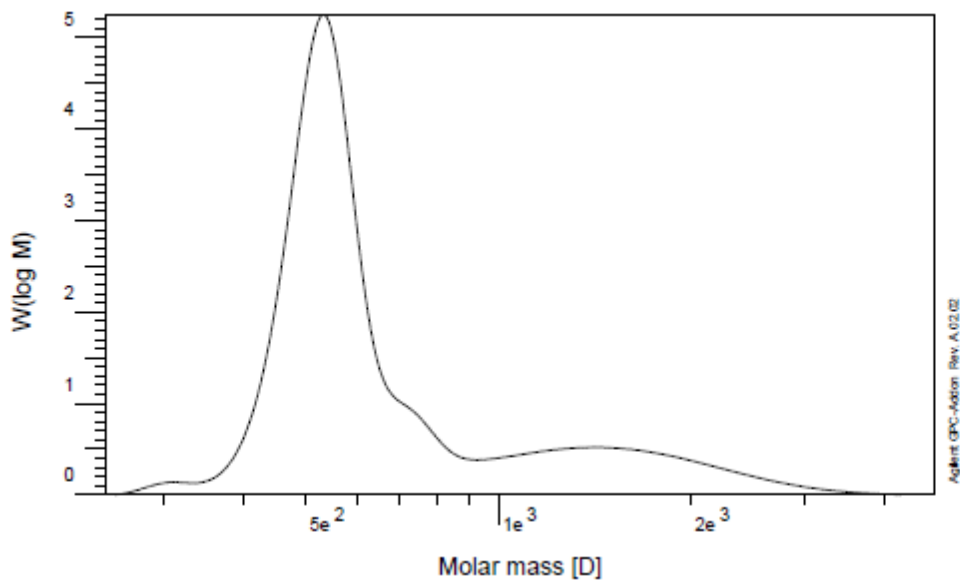


Sample : /  
 Injection Date :  
 Calibration File : CAL990312.CAL  
 Calibration Date :  
 Baseline from : 16.447 min  
 Integration from: 16.447 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : ...?  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPPJ  
 Baseline to : 19.738 min  
 Integration to : 19.738 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 23.000 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

**rid1A**  
**Mn** : 5.7779e2 g/mol  
**Mw** : 7.2206e2 g/mol  
**Mz** : 1.0356e3 g/mol  
**Mv** : 0.000000 g/mol  
**D** : 1.2497e0  
**[n]** : 0.000000 ml/g  
**Vp** : 1.8662e1 ml  
**Mp** : 5.1572e2 g/mol  
**A** : 4.2152e3 ml<sup>3</sup>/V  
**< 174** : 0.00  
**w%** : 100.00  
**> 4893** : 0.00

Fig S10. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-hexene}] = 0.08 \text{ mol}$ ,  $t = 9 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$



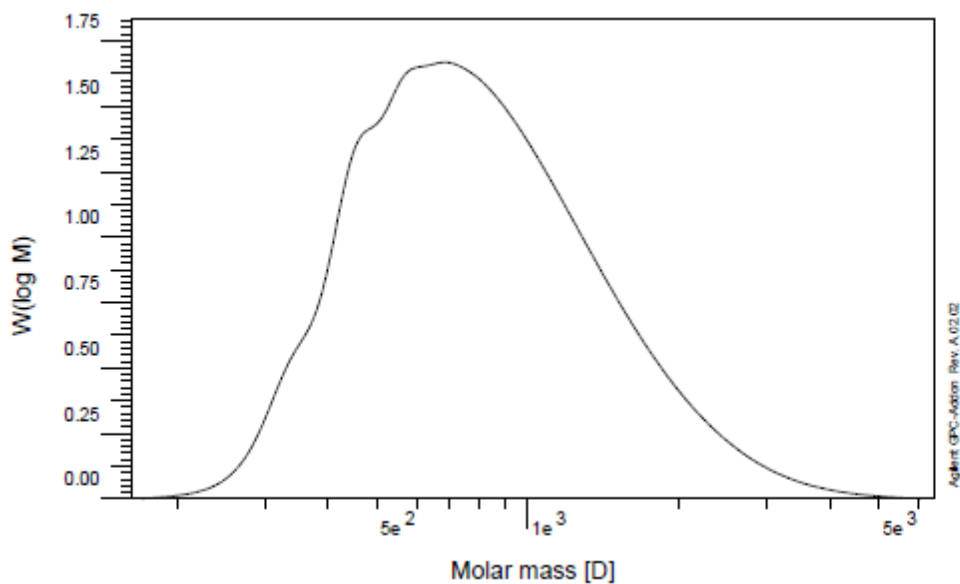
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**Injection Date :** 18-Jun-20, 11:17:22  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEMICAL990312.CAL  
**Calibration Date :** Tuesday 20/06/09 13:51:38  
**Baseline from :** 16.465 min  
**Integration from :** 16.465 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.409 min  
**Integration to :** 19.409 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000  $\mu$ l  
**Temperature :** 29.980 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**  
**Mn :** 6.1039e2 g/mol  
**Mw :** 7.6793e2 g/mol  
**Mz :** 1.1045e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.2581e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8633e1 ml  
**Mp :** 5.3092e2 g/mol  
**A :** 4.9604e3 ml<sup>2</sup>/V  
**< 243 :** 0.00  
**w% :** 100.00  
**> 4807 :** 0.00

Fig S11. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu$ mol, [1-hexene]= 0.08 mol, t=18 h,

Al/M= 500, T=80 °C



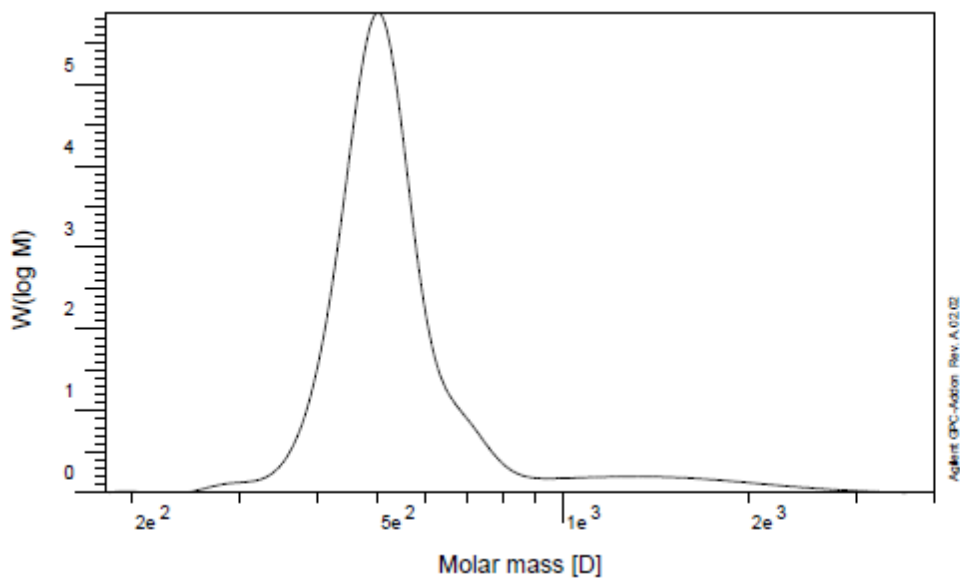


**Sample :** ZR-HEX-80  
**Injection Date :** 12-Dec-17, 12:58:56  
**Calibration File :** C:\HPCHEM\1\DATA\13960802\96-09-01-cal-01.CAL  
**Calibration Date :** Thursday 17/11/30 09:46:40  
**Baseline from :** 16.080 min  
**Integration from:** 16.080 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.654 min  
**Integration to :** 19.654 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 29.970 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**  
**Mn :** 6.9167e2 g/mol  
**Mw :** 9.2053e2 g/mol  
**Mz :** 1.2805e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.3309e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8259e1 ml  
**Mp :** 6.8406e2 g/mol  
**A :** 1.7531e4 ml<sup>3</sup>/V  
**< 162 :** 0.00  
**w% :** 100.00  
**> 6475 :** 0.00

Fig S12. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-hexene]= 0.08 mol, t=24 h,

Al/M= 500, T=80 °C

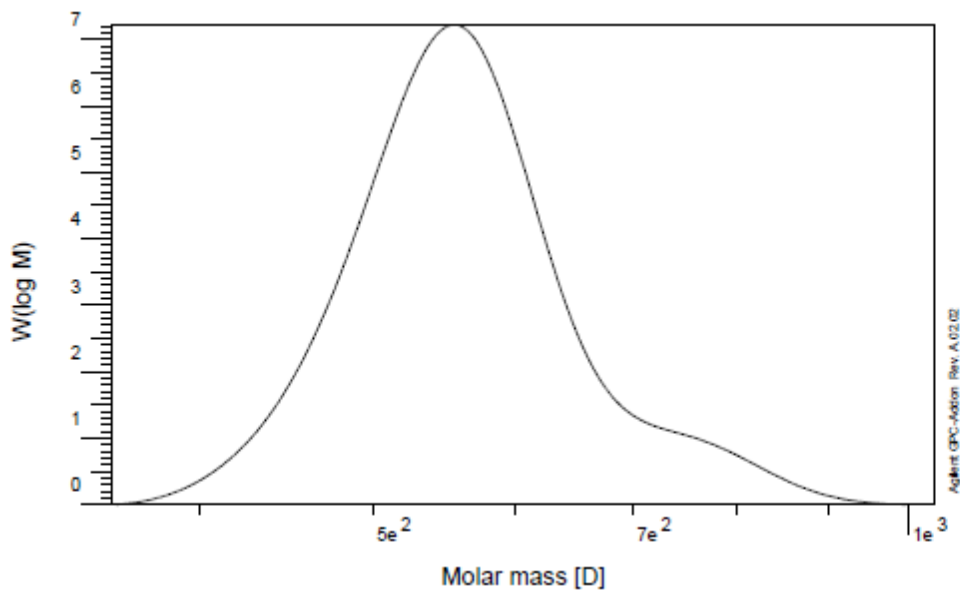


Sample : 7  
 Injection Date : 09-Jun-20, 08:59:01  
 Calibration File : C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
 Calibration Date : Tuesday 20/06/09 13:51:38  
 Baseline from : 16.638 min  
 Integration from : 16.638 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : PLgel OH-MIXED C  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPP1  
 Baseline to : 19.699 min  
 Integration to : 19.699 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 29.930 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

rid1A  
 Mn : 5.2525e2 g/mol  
 Mw : 5.9471e2 g/mol  
 Mz : 7.6838e2 g/mol  
 Mv : 0.000000 g/mol  
 D : 1.1322e0  
 [n] : 0.000000 ml/g  
 Vp : 1.8691e1 ml  
 Mp : 5.0096e2 g/mol  
 A : 4.1071e3 ml<sup>2</sup>/V  
 < 180 0.00  
 w% : 100.00  
 > 4024 0.00

Fig S13. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-octene]= 0.08 mol, t=3 h,

Al/M= 500, T=80 °C



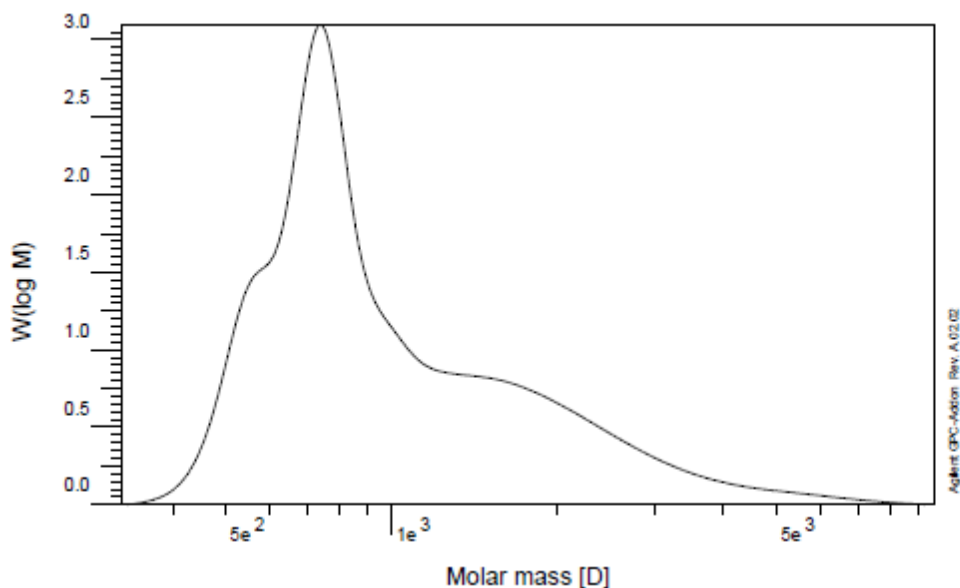
**Sample :** 4  
**Injection Date :** 18-Jun-20, 07:56:51  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
**Calibration Date :** Tuesday 20/06/09 13:51:38  
**Baseline from :** 17.973 min  
**Integration from :** 17.973 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPPJ

**Baseline to :** 19.029 min  
**Integration to :** 19.029 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 30.000 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**  
**Mn :** 5.5581e2 g/mol  
**Mw :** 5.6812e2 g/mol  
**Mz :** 5.8183e2 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.0225e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8590e1 ml  
**Mp :** 5.5451e2 g/mol  
**A :** 3.7559e3 ml<sup>2</sup>/V  
**< 356 :** 0.00  
**w% :** 100.00  
**> 1034 :** 0.00

Fig S14. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-octene}] = 0.08 \text{ mol}$ ,  $t = 9 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$

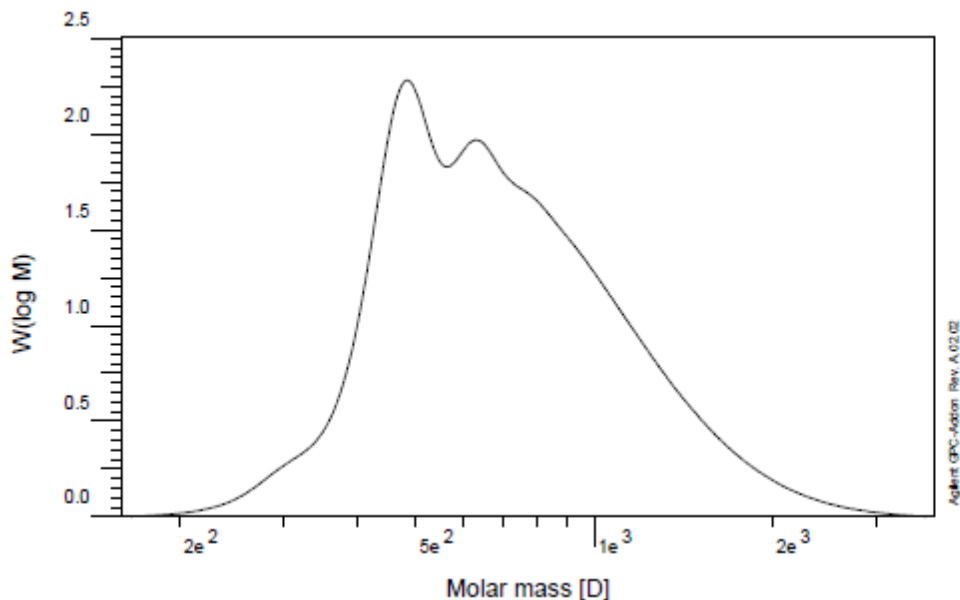


Sample : 2  
 Injection Date : 18-Jun-20, 10:15:41  
 Calibration File : C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
 Calibration Date : Tuesday 20/06/09 13:51:38  
 Baseline from : 15.784 min  
 Integration from : 15.784 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : PLgel OH-MIXED C  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPP1  
 Baseline to : 19.130 min  
 Integration to : 19.130 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 29.990 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

**rid1A**  
**M<sub>n</sub>** : 8.7898e2 g/mol  
**M<sub>w</sub>** : 1.2015e3 g/mol  
**M<sub>z</sub>** : 1.9092e3 g/mol  
**M<sub>v</sub>** : 0.000000 g/mol  
**D** : 1.3670e0  
**[n]** : 0.000000 ml/g  
**V<sub>p</sub>** : 1.8302e1 ml  
**M<sub>p</sub>** : 7.4127e2 g/mol  
**A** : 5.4024e3 ml<sup>3</sup>/V  
**< 322** : 0.00  
**w%** : 100.00  
**> 9680** : 0.00

Fig S15. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-octene]= 0.08 mol, t=18 h,

Al/M= 500, T=80 °C



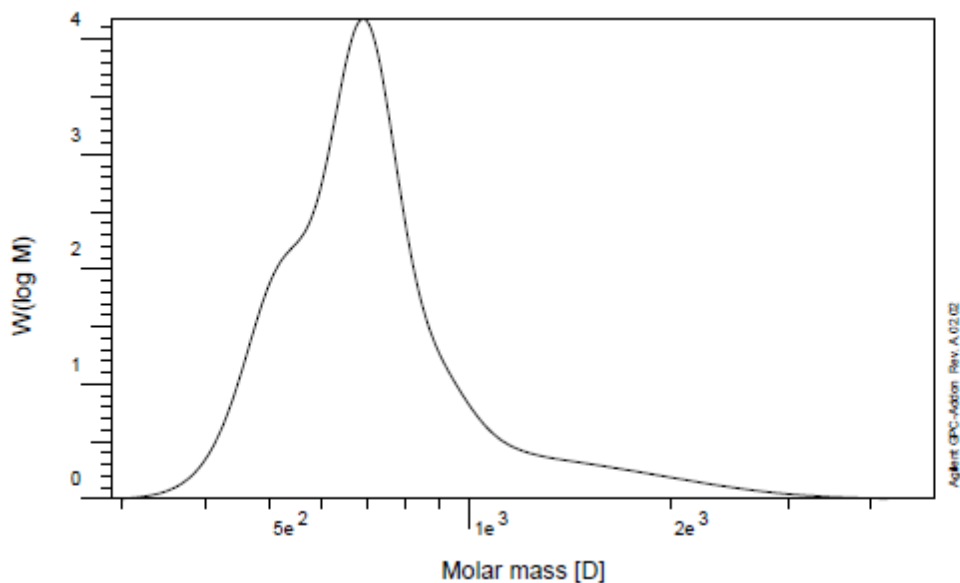
Sample : r-zr-oct-80  
 Injection Date : 22-Jan-18, 12:57:18  
 Calibration File : C:\HPCHEM\1\DATA\13960802\96-10-01-cal-01.CAL  
 Calibration Date : Thursday 18/01/18 08:55:00  
 Baseline from : 16.619 min  
 Integration from : 16.619 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : PLgel OH-MIXED C  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPP1  
 Baseline to : 19.693 min  
 Integration to : 19.693 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 30.000 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

**rid1A**

**Mn** : 6.3162e2 g/mol  
**Mw** : 7.7529e2 g/mol  
**Mz** : 9.7806e2 g/mol  
**Mv** : 0.000000 g/mol  
**D** : 1.2275e0  
**[n]** : 0.000000 ml/g  
**Vp** : 1.8612e1 ml  
**Mp** : 4.8413e2 g/mol  
**A** : 4.5502e3 ml<sup>2</sup>/V  
**< 160** : 0.00  
**w%** : 100.00  
**> 3760** : 0.00

Fig S16. GPC curve of prepared oligomer with  $\text{Cp}_2\text{ZrCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-octene]= 0.08 mol, t=24 h,

Al/M= 500, T=80 °C



**Sample :** 8  
**Injection Date :**  
**Calibration File :** CAL990312.CAL  
**Calibration Date :**  
**Baseline from :** 16.428 min  
**Integration from:** 16.428 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** ....?  
**Concentration :** 1.000 g/l  
**Column 1 :** ....?  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1

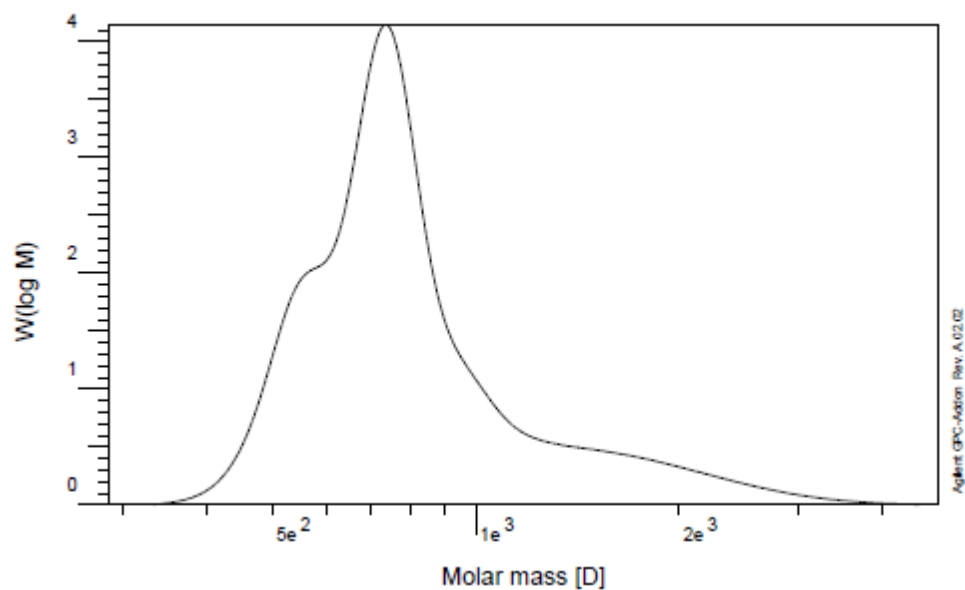
**Baseline to :** 19.234 min  
**Integration to :** 19.234 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 23.000 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**

<b>Mn :</b>	6.8284e2	g/mol
<b>Mw :</b>	7.7689e2	g/mol
<b>Mz :</b>	9.5695e2	g/mol
<b>Mv :</b>	0.000000	g/mol
<b>D :</b>	1.1377e0	
<b>[n] :</b>	0.000000	ml/g
<b>Vp :</b>	1.8374e1	ml
<b>Mp :</b>	6.8934e2	g/mol
<b>A :</b>	4.8463e3	ml <sup>2</sup> /V
<b>10% :</b>	4.9251e2	g/mol
<b>30% :</b>	6.0480e2	g/mol
<b>60% :</b>	7.2664e2	g/mol
<b>85% :</b>	9.5542e2	g/mol
<b>90% :</b>	1.1248e3	g/mol

Fig S17. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-hexene}] = 0.08 \text{ mol}$ ,  $t = 3 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$



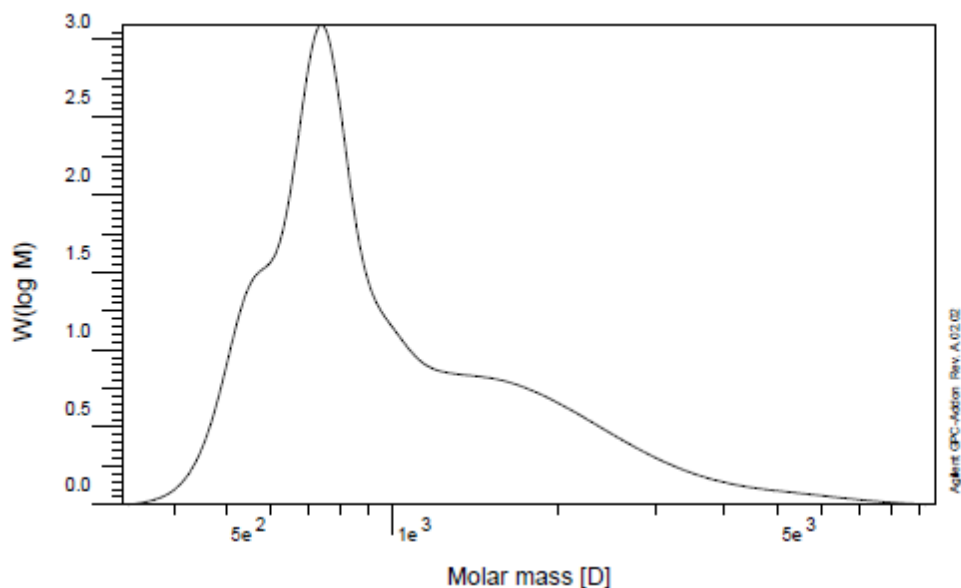
**Sample :** 7-SECOND  
**Injection Date :** 18-Jun-20, 10:44:35  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
**Calibration Date :** Tuesday 20/06/09 13:51:38  
**Baseline from :** 16.457 min  
**Integration from:** 16.457 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.247 min  
**Integration to :** 19.247 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 30.010 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**

**Mn :** 7.5435e2 g/mol  
**Mw :** 8.8157e2 g/mol  
**Mz :** 1.1188e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.1686e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8310e1 ml  
**Mp :** 7.3592e2 g/mol  
**A :** 5.5023e3 ml<sup>2</sup>/V  
**< 286 :** 0.00  
**w% :** 100.00  
**> 4845 :** 0.00

Fig S18. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-hexene}] = 0.08 \text{ mol}$ ,  $t = 9 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$



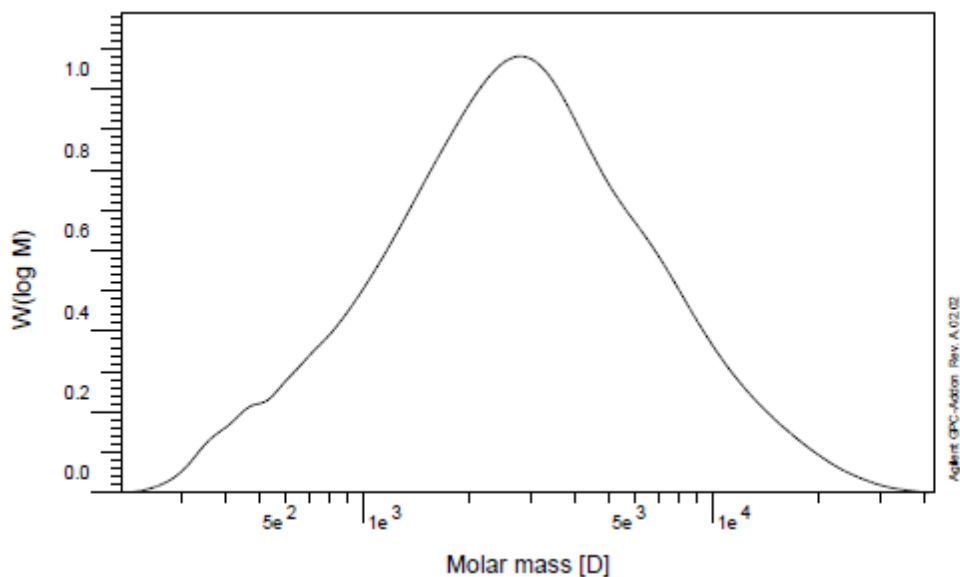
**Sample :** 2  
**Injection Date :** 18-Jun-20, 10:15:41  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEMICAL990312.CAL  
**Calibration Date :** Tuesday 20/06/09 13:51:38  
**Baseline from :** 15.784 min  
**Integration from :** 15.784 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPPJ  
**Baseline to :** 19.130 min  
**Integration to :** 19.130 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 29.990 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**  
**Mn :** 8.7898e2 g/mol  
**Mw :** 1.2015e3 g/mol  
**Mz :** 1.9092e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.3670e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8302e1 ml  
**Mp :** 7.4127e2 g/mol  
**A :** 5.4024e3 ml<sup>2</sup>/V  
**< 322 :** 0.00  
**w% :** 100.00  
**> 9680 :** 0.00

Fig S19. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-hexene]= 0.08 mol, t=18 h,

Al/M= 500, T=80 °C



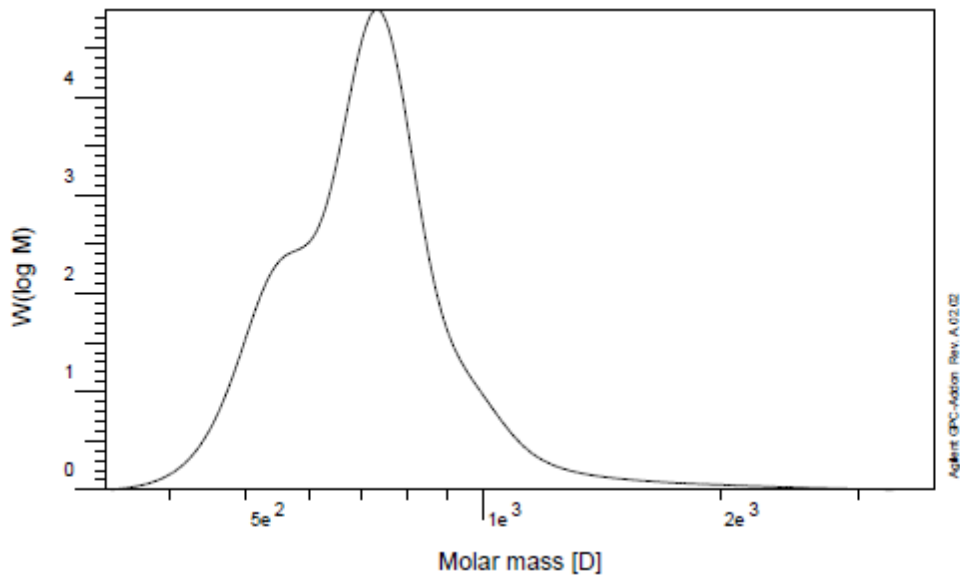


**Sample :** HF-HEX-RT  
**Injection Date :** 19-Dec-17, 09:25:29  
**Calibration File :** C:\HPCHEM\1\DATA\13960802\06-09-01-cal-01.CAL  
**Calibration Date :** Thursday 17/11/30 09:46:40  
**Baseline from :** 14.241 min  
**Integration from:** 14.241 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.443 min  
**Integration to :** 19.443 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 29.980 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**  
**Mn :** 1.8160e3 g/mol  
**Mw :** 3.9828e3 g/mol  
**Mz :** 7.9717e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 2.1932e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8891e1 ml  
**Mp :** 2.8052e3 g/mol  
**A :** 8.0696e3 ml<sup>2</sup>/V  
**< 200** 0.00  
**w% :** 100.00  
**> 43180** 0.00

Fig S20. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-hexene]= 0.08 mol, t=24 h,

Al/M= 500, T=80 °C



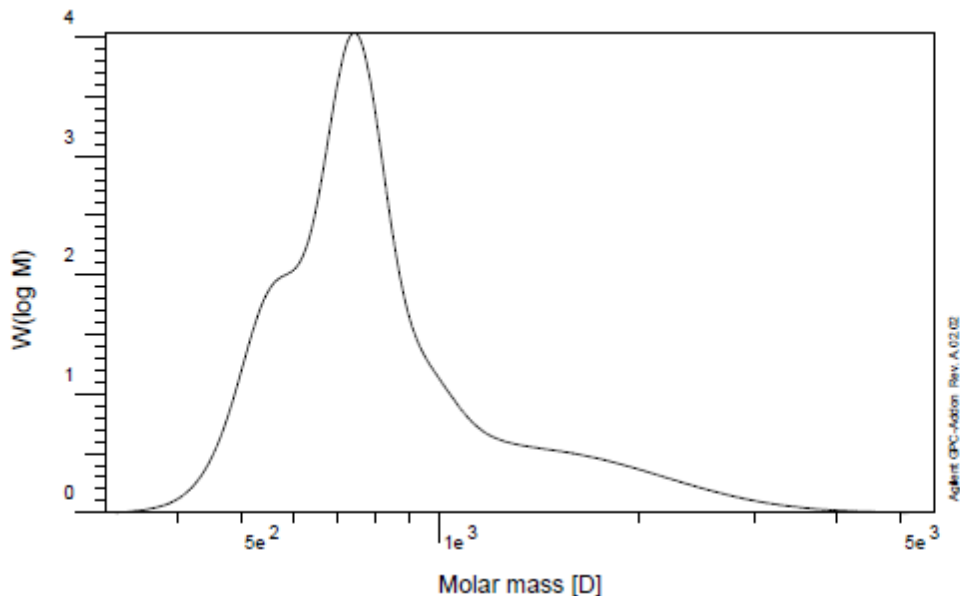
Sample :	1		
Injection Date :	18-Jun-20, 09:18:44		
Calibration File :	C:\HPCHEM\1\DATA\KAZEMICAL990312.CAL		
Calibration Date :	Tuesday 20/06/09 13:51:38		
Baseline from :	16.709 min	Baseline to :	19.102 min
Integration from :	16.709 min	Integration to :	19.102 min
MHK - A (Cal.):	0.000000E+0	MHK - K (Cal.):	1.000000E+0 ml/g
Eluent :	THF	Flowrate :	1.000 ml/min
Concentration :	1.000 g/l	Inject volume :	20.000 ul
Column 1 :	PLgel OH-MIXED C	Temperature :	30.000 C
Detector 1 :	RID A, Refractive Index Signal	Delay volume :	0.000 ml
Operator :	IPPI	Acquisition interval :	0.430 sec

**rid1A**

<b>Mn :</b>	6.8952e2	g/mol
<b>Mw :</b>	7.3789e2	g/mol
<b>Mz :</b>	8.0995e2	g/mol
<b>Mv :</b>	0.000000	g/mol
<b>D :</b>	1.0701e0	
<b>[n] :</b>	0.000000	ml/g
<b>Vp :</b>	1.8317e1	ml
<b>Mp :</b>	7.3062e2	g/mol
<b>A :</b>	5.6647e3	ml <sup>3</sup> /V
<b>&lt; 330</b>	0.00	
<b>w% :</b>	100.00	
<b>&gt; 3744</b>	0.00	

Fig S21. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-octene}] = 0.08 \text{ mol}$ ,  $t = 3 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$



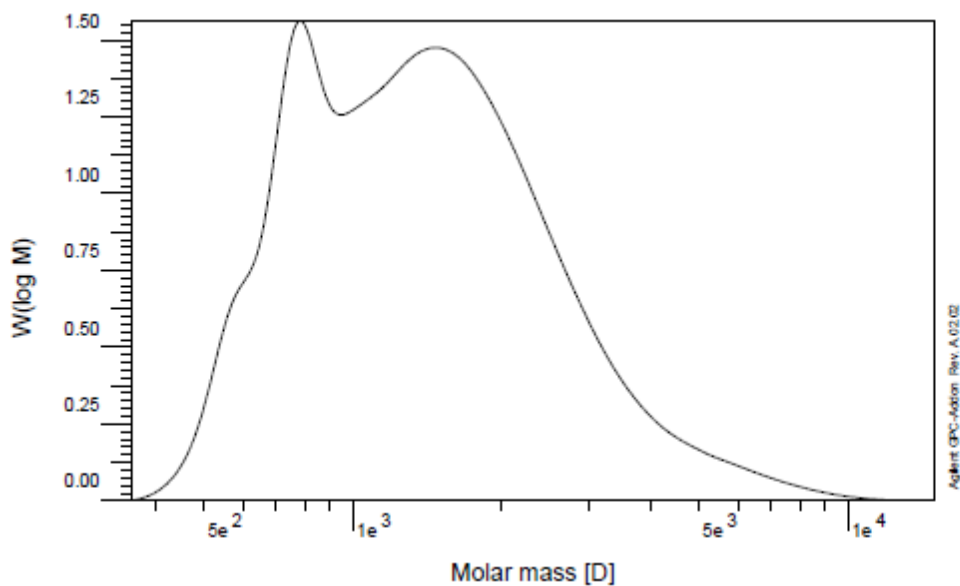
**Sample :** 3  
**Injection Date :** 18-Jun-20, 09:47:49  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEM\ICAL990312.CAL  
**Calibration Date :** Tuesday 20/06/09 13:51:38  
**Baseline from :** 16.311 min  
**Integration from :** 16.311 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.161 min  
**Integration to :** 19.161 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 30.010 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**rid1A**

**Mn :** 7.6988e2 g/mol  
**Mw :** 9.1024e2 g/mol  
**Mz :** 1.1746e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.1823e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8302e1 ml  
**Mp :** 7.4127e2 g/mol  
**A :** 4.9706e3 ml<sup>1</sup>V  
**< 312 :** 0.00  
**w% :** 100.00  
**> 5630 :** 0.00

Fig S22. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-octene]= 0.08 mol, t=9 h,

Al/M= 500, T=80 °C

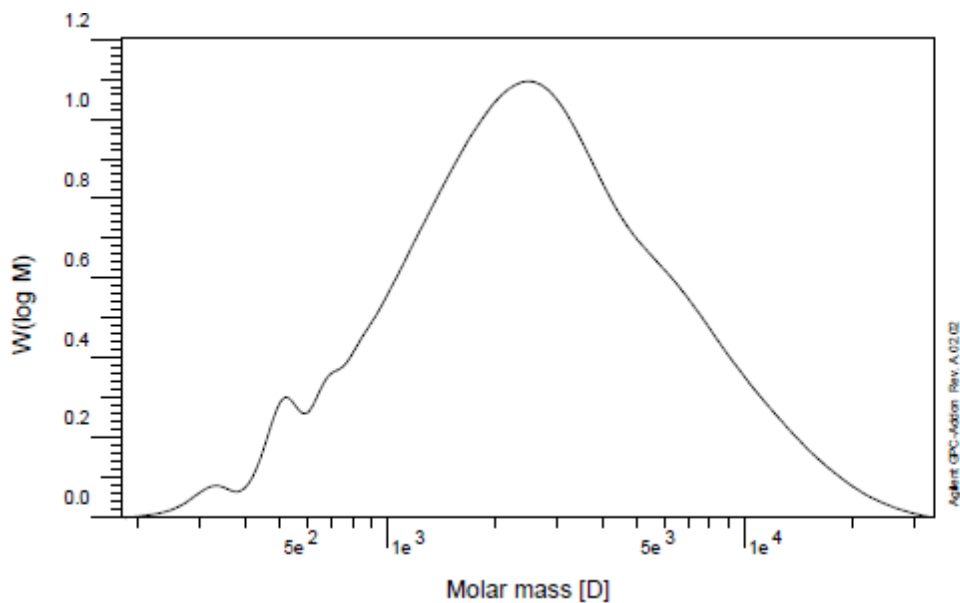


**Sample :** 5  
**Injection Date :** 18-Jun-20, 07:28:56  
**Calibration File :** C:\HPCHEM\1\DATA\KAZEM\CAL990312.CAL  
**Calibration Date :** Tuesday, 20/06/09 13:51:38  
**Baseline from :** 15.360 min  
**Integration from :** 15.360 min  
**MHK - A (Cal.):** 0.000000E+0  
**Eluent :** THF  
**Concentration :** 1.000 g/l  
**Column 1 :** PLgel OH-MIXED C  
**Detector 1 :** RID A, Refractive Index Signal  
**Operator :** IPP1  
**Baseline to :** 19.029 min  
**Integration to :** 19.029 min  
**MHK - K (Cal.):** 1.000000E+0 ml/g  
**Flowrate :** 1.000 ml/min  
**Inject volume :** 20.000 ul  
**Temperature :** 29.990 C  
**Delay volume :** 0.000 ml  
**Acquisition interval :** 0.430 sec

**ridA**  
**Mn :** 1.1865e3 g/mol  
**Mw :** 1.6566e3 g/mol  
**Mz :** 2.4828e3 g/mol  
**Mv :** 0.000000 g/mol  
**D :** 1.3963e0  
**[n] :** 0.000000 ml/g  
**Vp :** 1.8245e1 ml  
**Mp :** 7.8569e2 g/mol  
**A :** 4.0481e3 ml<sup>3</sup>/V  
**< 356 :** 0.00  
**w% :** 100.00  
**> 15012 :** 0.00

Fig S23. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ , [cat]= 10  $\mu\text{mol}$ , [1-octene]= 0.08 mol, t=18 h,

Al/M= 500, T=80 °C



Sample : R-hf-OCT-80  
 Injection Date : 22-Jan-18, 09:15:45  
 Calibration File : C:\HPCHEM\1\DATA\13960802\96-10-01-cal-01.CAL  
 Calibration Date : Thursday 18/01/18 08:55:00  
 Baseline from : 14.473 min  
 Integration from : 14.473 min  
 MHK - A (Cal.): 0.000000E+0  
 Eluent : THF  
 Concentration : 1.000 g/l  
 Column 1 : PLgel OH-MIXED C  
 Detector 1 : RID A, Refractive Index Signal  
 Operator : IPP1  
 Baseline to : 19.575 min  
 Integration to : 19.575 min  
 MHK - K (Cal.): 1.000000E+0 ml/g  
 Flowrate : 1.000 ml/min  
 Inject volume : 20.000 ul  
 Temperature : 29.990 C  
 Delay volume : 0.000 ml  
 Acquisition interval : 0.430 sec

**rid1A**  
**Mn** : 1.7754e3 g/mol  
**Mw** : 3.7812e3 g/mol  
**Mz** : 7.4647e3 g/mol  
**Mv** : 0.000000 g/mol  
**D** : 2.1298e0  
**[n]** : 0.000000 ml/g  
**Vp** : 1.7021e1 ml  
**Mp** : 2.4882e3 g/mol  
**A** : 3.3221e3 ml<sup>2</sup>/V  
**< 180** : 0.00  
**w%** : 100.00  
**> 34213** : 0.00

Fig S24. GPC curve of prepared oligomer with  $\text{Cp}_2\text{HfCl}_2$ ,  $[\text{cat}] = 10 \mu\text{mol}$ ,  $[\text{1-octene}] = 0.08 \text{ mol}$ ,  $t = 24 \text{ h}$ ,

$\text{Al/M} = 500$ ,  $T = 80 \text{ }^\circ\text{C}$