Material Testing Report

Material –1196

POLYLAC PA-709

Prepared for:

CHI MEI CORPORATION

by:

CoreTech System Material Testing Lab
Tai Yuen Hi-Tech Industrial Park
Hsinchu

Authorized by:

Ms/ F.C. Liu
Lab Manager

Jan. 09, 2014

Contents

Parameter Summary

Viscosity

Model	Parameter	Value	Unit
Modified Cross Model (3)	n	2.2609E-01	-
	Taus	1.0470E+06	dyne/cm^2
	D1	1.4503E+13	g/cm s
	D2	3.7815E+02	K
	D3	0.0000E+00	cm^2/dyne
	A1	2.7231E+01	1/K
	A2	5.1600E+01	K

Pressure – Volume – Temperature

Model	Parameter	Value	Unit
Modified Tait Model (2)	b1L	1.0052E+00	cc/g
	b2L	5.4072E-04	cc/g K
	b3L	7.4540E+08	dyne/cm^2
	b4L	2.1793E-03	1/K
	b1S	1.0048E+00	cc/g
	b2S	3.0141E-04	cc/g K
	b3S	8.2790E+08	dyne/cm^2
	b4S	3.1068E-03	1/K
	b5	3.6815E+02	K
	b6	1.4706E-08	cm^2 K/dyne
	b7	0.0000E+00	cc/g
	b8	0.0000E+00	1/K
	b9	0.0000E+00	cm^2 K/dyne

Heat capacity

Model	**Temperature,** °C	**Value,** erg/g °C
Tabulated Data	32	1.38E+07
	60	1.51E+07
	80	1.61E+07
	100	1.81E+07
	108	2.13E+07
	110	2.19E+07
	114	2.05E+07
	116	2.03E+07
	150	2.12E+07
	180	2.19E+07
	210	2.25E+07
	240	2.31E+07

Thermal conductivity

Model	**Temperature,** °C	**Value,** erg/s cm °C
Tabulated Data	60	20300
	90	21000
	120	22900
	150	23200
	180	24000
	210	24600
	240	23200

Material description

Grade Name: PA-709
Supplier: Chi-Mei
Date received: 2013.11.18

Recommended processing condition:

Drying condition:	80℃, 4 hours*
Melt temperature:	200–245℃*
Mold temperature:	60–100℃*
Ejection temperature:	110℃*

* from datasheet provided by supplier,

* * from thermal properties of DSC measurement

Viscosity

Instrument: Capillary rheometer, GOTECH CR-6000
Procedure: ASTM D3835
Sample drying condition: 80℃, 4 hours
Moisture level after drying: <0.01%
Sample shape: Pellet

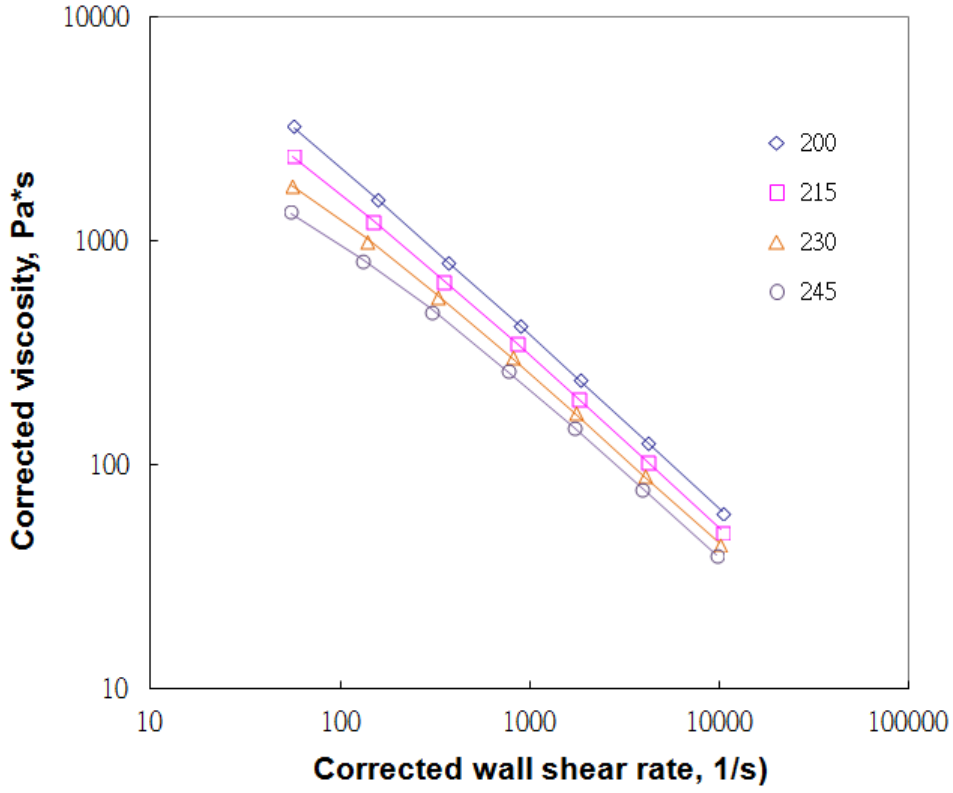
Capillary rheometer specifications

Die length: 30 mm
Die diameter: 1 mm
Die entry angle: 90 degrees
Barrel diameter: 12 mm
Corrections: Rabinowitsch

Test Data

Temperature, ℃	Apparent shear rate, s^{-1}	Apparent viscosity, s^{-1}	Corrected shear rate, s^{-1}	Corrected viscosity, s^{-1}
200	50.00	3667.15	56.91	3221.98
	100.00	2361.84	155.41	1519.74
	200.00	1467.47	367.85	797.87
	500.00	741.82	891.75	415.94
	1000.00	437.05	1822.16	239.85
	2000.00	261.89	4175.00	125.46
	5000.00	126.57	10437.49	60.63
215	50.00	2697.49	56.26	2397.13
	100.00	1796.90	146.98	1222.53
	200.00	1142.40	348.12	656.32
	500.00	590.03	844.18	349.47
	1000.00	354.24	1789.35	197.97
	2000.00	211.41	4097.79	103.18
	5000.00	103.40	10244.48	50.47
230	50.00	1923.01	55.20	1741.69
	100.00	1357.66	136.48	994.78
	200.00	894.80	318.18	562.44
	500.00	484.35	798.92	303.13
	1000.00	293.21	1732.19	169.27
	2000.00	177.06	3961.51	89.39

	5000.00	87.42	9903.77	44.13
245	50.00	1478.66	54.81	1348.77
	100.00	1067.45	131.18	813.75
	200.00	725.93	301.32	481.84
	500.00	405.39	760.76	266.43
	1000.00	250.27	1692.53	147.87
	2000.00	151.13	3845.40	78.61
	5000.00	75.83	9613.50	39.44

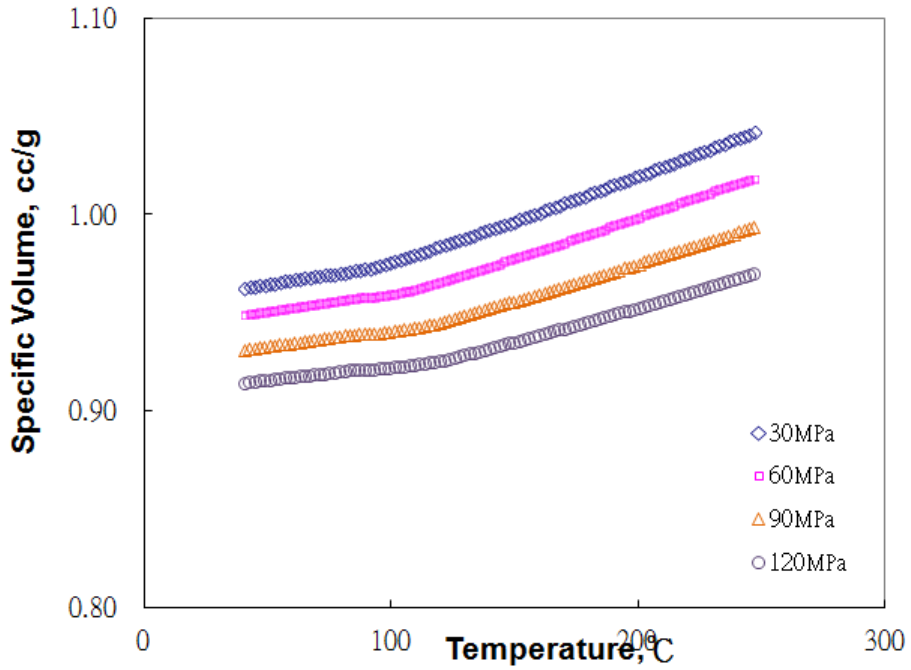


Dot: measurement data

Line: model predictions using parameters provided

Pressure-Volume-Temperature

Instrument:	GOTECH PVT100 (piston type)
Procedure:	ISO 17744, isobaric cooling 5℃/min
Sample drying condition:	80℃, 4 hours
Moisture level after drying:	<0.01%
Sample shape:	Pellet



Dot: measurement data

Line: model predictions using parameters provided

Test Data

Temperature, ℃	Specific volume, cc/g			
	30 MPa	60 MPa	90 MPa	120 MPa
246	1.0424	1.0181	0.9941	0.9704
244	1.0414	1.0175	0.9933	0.9696
242	1.0406	1.0168	0.9925	0.9688
240	1.0396	1.0161	0.9916	0.9680
238	1.0388	1.0153	0.9906	0.9672
236	1.0378	1.0145	0.9898	0.9664
234	1.0370	1.0138	0.9890	0.9656
232	1.0357	1.0129	0.9881	0.9649

230	1.0347	1.0121	0.9872	0.9640
228	1.0337	1.0111	0.9864	0.9632
226	1.0328	1.0103	0.9855	0.9625
224	1.0318	1.0094	0.9848	0.9618
222	1.0309	1.0085	0.9839	0.9609
220	1.0301	1.0076	0.9832	0.9603
218	1.0291	1.0067	0.9824	0.9595
216	1.0280	1.0059	0.9815	0.9588
214	1.0270	1.0049	0.9808	0.9581
212	1.0261	1.0041	0.9800	0.9573
210	1.0251	1.0032	0.9792	0.9567
208	1.0242	1.0022	0.9784	0.9559
206	1.0234	1.0014	0.9777	0.9552
204	1.0224	1.0006	0.9769	0.9545
202	1.0215	0.9997	0.9762	0.9538
200	1.0203	0.9988	0.9753	0.9530
198	1.0194	0.9979	0.9745	0.9523
196	1.0184	0.9971	0.9738	0.9516
194	1.0175	0.9962	0.9731	0.9509
192	1.0166	0.9953	0.9723	0.9502
190	1.0157	0.9945	0.9714	0.9496
188	1.0148	0.9936	0.9707	0.9488
186	1.0140	0.9928	0.9699	0.9482
184	1.0128	0.9919	0.9692	0.9475
182	1.0119	0.9910	0.9684	0.9468
180	1.0110	0.9901	0.9676	0.9460
178	1.0100	0.9892	0.9667	0.9453
176	1.0091	0.9884	0.9661	0.9446
174	1.0082	0.9876	0.9653	0.9439
172	1.0074	0.9867	0.9645	0.9432
170	1.0065	0.9859	0.9637	0.9424
168	1.0054	0.9850	0.9630	0.9418
166	1.0044	0.9842	0.9622	0.9411
164	1.0035	0.9833	0.9614	0.9404
162	1.0026	0.9825	0.9607	0.9398
160	1.0017	0.9817	0.9599	0.9390
158	1.0008	0.9808	0.9592	0.9383
156	0.9999	0.9800	0.9584	0.9376
154	0.9991	0.9793	0.9577	0.9369

152	0.9982	0.9785	0.9569	0.9362
149	0.9971	0.9775	0.9561	0.9356
147	0.9962	0.9768	0.9555	0.9349
145	0.9954	0.9760	0.9547	0.9341
143	0.9945	0.9751	0.9540	0.9335
141	0.9937	0.9744	0.9532	0.9328
139	0.9928	0.9736	0.9525	0.9322
137	0.9919	0.9728	0.9518	0.9315
135	0.9912	0.9720	0.9511	0.9309
133	0.9901	0.9712	0.9504	0.9302
131	0.9893	0.9704	0.9497	0.9295
129	0.9884	0.9696	0.9489	0.9288
127	0.9877	0.9688	0.9482	0.9281
125	0.9870	0.9681	0.9475	0.9275
123	0.9861	0.9673	0.9467	0.9269
121	0.9854	0.9664	0.9460	0.9263
119	0.9845	0.9656	0.9453	0.9258
117	0.9837	0.9648	0.9447	0.9254
115	0.9826	0.9641	0.9441	0.9249
113	0.9819	0.9634	0.9435	0.9246
111	0.9809	0.9627	0.9431	0.9243
109	0.9800	0.9620	0.9426	0.9239
107	0.9791	0.9613	0.9422	0.9236
105	0.9783	0.9607	0.9418	0.9233
103	0.9775	0.9602	0.9414	0.9230
101	0.9766	0.9597	0.9411	0.9227
99	0.9758	0.9592	0.9407	0.9224
97	0.9750	0.9587	0.9403	0.9222
95	0.9744	0.9584	0.9401	0.9219
93	0.9738	0.9583	0.9400	0.9218
91	0.9733	0.9581	0.9398	0.9217
89	0.9729	0.9579	0.9397	0.9215
87	0.9725	0.9577	0.9395	0.9215
85	0.9720	0.9575	0.9392	0.9212
83	0.9716	0.9571	0.9390	0.9211
81	0.9710	0.9568	0.9386	0.9208
79	0.9706	0.9564	0.9383	0.9205
77	0.9704	0.9560	0.9379	0.9202
75	0.9701	0.9555	0.9374	0.9198

73	0.9697	0.9550	0.9371	0.9195
71	0.9695	0.9546	0.9367	0.9191
69	0.9691	0.9542	0.9363	0.9189
67	0.9688	0.9539	0.9360	0.9186
65	0.9684	0.9535	0.9357	0.9184
63	0.9679	0.9531	0.9354	0.9181
61	0.9675	0.9528	0.9350	0.9178
59	0.9671	0.9524	0.9347	0.9176
57	0.9666	0.9521	0.9344	0.9173
55	0.9662	0.9518	0.9340	0.9171
53	0.9658	0.9514	0.9337	0.9167
51	0.9653	0.9510	0.9333	0.9164
48	0.9649	0.9506	0.9330	0.9161
46	0.9645	0.9502	0.9327	0.9157
44	0.9640	0.9499	0.9323	0.9154
42	0.9635	0.9494	0.9319	0.9150
40	0.9629	0.9490	0.9315	0.9146

Heat capacity

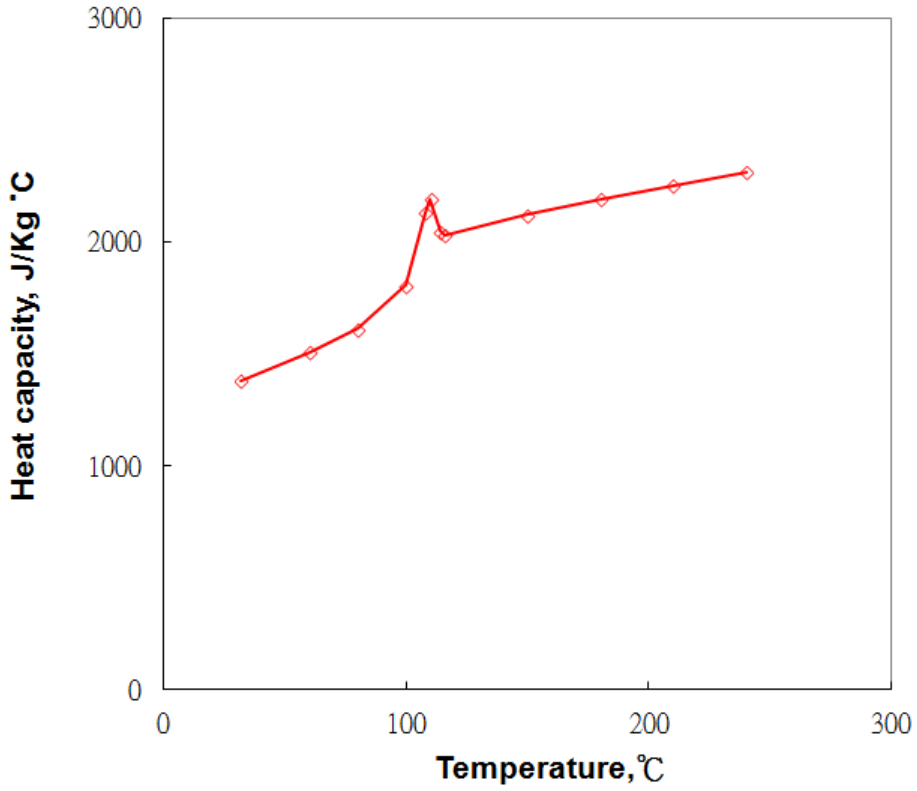
Instrument:	Perkin Elmer 8500
Procedure:	ASTM E1269
Sample drying condition:	80℃, 4 hours
Moisture level after drying:	<0.01%
Sample shape:	Pellet
Sample weight:	5.6 mg

Test specifications

Temperature range:	250-30℃
Cooling rate:	20℃/min
Purge gas:	Nitrogen

Data

Temperature, °C	Heat capacity, J/Kg °C
32	1382
60	1509
80	1612
100	1808
108	2132
110	2193
114	2050
116	2033
150	2123
180	2193
210	2254
240	2313

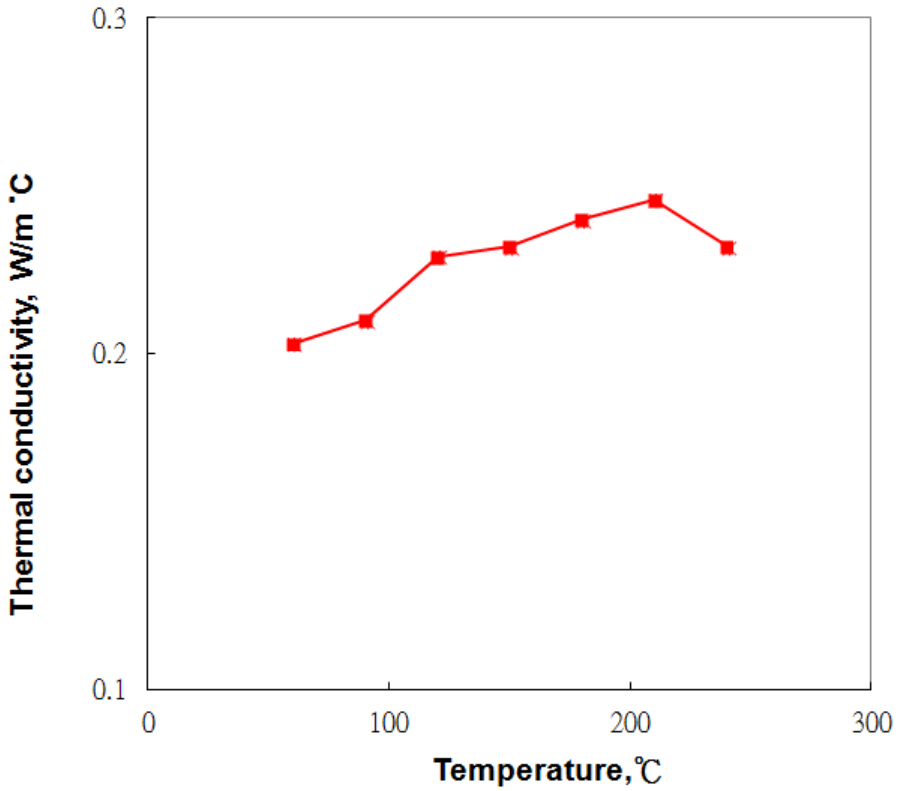

3000
2000
1000
0
Heat capacity, J/Kg ˚C
0
100
200
300
Temperature,℃

Thermal conductivity

Instrument:	GOTTFERT RG25
Procedure:	ASTM D 5930
Sample drying condition:	80℃, 4 hours
Moisture level after drying:	<0.01%
Sample shape:	Pellet

Data

Temperature, ℃	Thermal conductivity, W/m ℃
60	0.203
90	0.210
120	0.229
150	0.232
180	0.240
210	0.246
240	0.232



Contact details

Material Testing Lab

CoreTech System Co., Ltd.

Tai Yuen Hi-Tech Industrial Park,

8F-2, No.32, Taiyuan St.

Chupei City, Hsinchu County 302, Taiwan

- Tel: +886-3-560-0199
- Fax:+886-3-560-0198
- tr3@moldex3d.com