

# Material Testing Report

BKSMT-0029

LFT-TPU-BG05

TPU

长纤（厦门）新材料科技有限公司

Report date: 2021-3-15

Test date: 2021-3-15

Measured by: Bangkesi CAE material Lab

Authorized by: Tober

## Basic information

Manufacturer	长纤（厦门）新材料科技有限公司
Trade name	LFT-TPU-BG05
Family name	TPU
Filler	Long Glass fiber 50%
Material Type	Semi-crystalline

## Parameter Summary

### Recommended Processing:

Minimum Melt temperature:	220	°C
Maximum Melt temperature:	250	°C
General Melt temperature:	230	°C
Minimum Mold temperature:	50	°C
Maximum Mold temperature:	95	°C
General Mold temperature:	70	°C
Absolute maximum melt temperature:	270	°C
Ejection temperature:	109	°C
Transition temperature:	139	°C
Maximum shear stress:	0.25	MPa
Maximum shear rate:	40000	1/s

#### Note:

- ✧ Recommended temperature value is provided by material manufacture.
- ✧ Maximum shear stress and maximum shear rate values have been supplemented with generic estimates.

#### Operator's Notes:

- ✧ Testing was performed per standard testing procedures.
- ✧ No anomalies were noted during the course of testing.

## Viscosity:

Modified Cross Model(3) For Moldex3D		
$n$	0.2361	-
$\tau^*$	65221.00	dyne/cm2
$D_1$	9.99944E+25	poise
$D_2$	389.59	K
$D_3$	0.00	(dyne/cm2) <sup>-1</sup>
$A_1$	62.516	1/ K
$\tilde{A}_2$	51.60	K

Cross-WLF Model For Moldflow		
$n$	0.2361	-
$\tau^*$	6522.10	Pa
$D_1$	9.99944E+24	Pa-s
$D_2$	389.59	K
$D_3$	0.00	K/Pa
$A_1$	62.5160	1/ K
$\tilde{A}_2$	51.60	K

## Pressure-Volume-Temperature:

Melt density	1.4991	g/cm3
Solid density	1.621	g/cm3

2-domain modified Tait PVT model for Moldex3D		
b1L	0.6381	cc/g
b2L	0.0002884	cc/g-K
b3L	3973850000	dyne/cm2
b4L	0.005942	1/K
b1s	0.6175	cc/g
b2s	0.000005419	cc/g-K
b3s	6674840000	dyne/cm2
b4s	0.0008538	1/K
b5	412.82	K

b6	1.11E-08	cm2.K/dyne
b7	0.02061	cc/g
b8	0.02592	1/K
b9	6.102E-10	cm2/dyne

2-domain modified Tait PVT model for Moldflow		
<i>b5</i>	412.82	K
<i>b6</i>	1.11000E-07	K/Pa
<i>b1l</i>	6.38100E-04	m3/Kg
<i>b2m</i>	2.88400E-07	m3/(Kg K)
<i>b3m</i>	3.97385E+08	Pa
<i>b4m</i>	5.94200E-03	1/K
<i>b1s</i>	6.17500E-04	m3/Kg
<i>b2s</i>	5.41900E-09	m3/(Kg K)
<i>b3s</i>	6.67484E+08	Pa
<i>b4s</i>	8.53800E-04	1/K
<i>b7</i>	2.06100E-05	m3/Kg
<i>b8</i>	0.02592	1/K
<i>b9</i>	6.10E-09	1/Pa

## Specific heat data:

Cp for Moldflow	
Temperature, °C	Cp, J/Kg K
30	1176.800
33	1187.900
36	1200.800
39	1211.270
42	1219.900
45	1227.890
48	1236.940
51	1249.250
54	1260.700
57	1280.860
60	1306.640
63	1334.670
66	1362.210
69	1395.340
72	1435.990
75	1473.330

78	1506.200
81	1529.310
83	1535.040
84	1534.240
86	1532.040
88	1534.370
90	1539.990
93	1546.520
96	1550.810
100	1557.110
110	1574.020
120	1589.620
140	1616.920
160	1652.570
180	1686.140
200	1720.300
220	1765.710
240	1813.880

Cp for Moldex3D	
Temperature, °C	Cp, erg/g.C
30	1.1768E+07
33	1.1879E+07
36	1.2008E+07
39	1.2113E+07
42	1.2199E+07
45	1.2279E+07
48	1.2369E+07
51	1.2493E+07
54	1.2607E+07
57	1.2809E+07
60	1.3066E+07
63	1.3347E+07
66	1.3622E+07
69	1.3953E+07
72	1.4360E+07
75	1.4733E+07
78	1.5062E+07
81	1.5293E+07
83	1.5350E+07
84	1.5342E+07

86	1.5320E+07
88	1.5344E+07
90	1.5400E+07
93	1.5465E+07
96	1.5508E+07
100	1.5571E+07
110	1.5740E+07
120	1.5896E+07
140	1.6169E+07
160	1.6526E+07
180	1.6861E+07
200	1.7203E+07
220	1.7657E+07
240	1.8139E+07

## Thermal conductivity data:

Thermal conductivity for Moldex3D	
Temperature, °C	erg/(sec.cm.°C)
260	35400.000
240	36000.000
220	36000.000
200	36300.000
180	34300.000
160	36300.000
140	36900.000
120	34900.000
100	33600.000
80	31700.000

Thermal conductivity for moldflow	
Temperature, °C	W/m K
260	0.354
240	0.36
220	0.36
200	0.363
180	0.343
160	0.363
140	0.369
120	0.349

100	0.336
80	0.317

## Mechanical Properties:

Elastic modulus	For moldflow		For Moldex3D	
1st principal direction [E1]	11611.20	Mpa	1.1611E+11	dyne/cm2
2nd principal direction [E2]	5972.20	Mpa	5.9722E+10	dyne/cm2

Poisson's ratio for moldflow & moldex3D	
Poisson's ratio [v12]	0.4600
Poisson's ratio [v23]	0.4600

Transversely isotropic coefficient of thermal expansion [CTE] data	
Alpha1	1.250600E-05
Alpha2	3.27137E-05

Shear modulus [G12] MPa	2370.41
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## Viscosity raw data:

**Test standard:** ASTM D4440

*Pressure drop across the die is measured for each flow rate, and viscosity-shear rate data are calculated*

**Test instrument:** Rotational Rheometer(Haake)

Temperature(°C)	Viscosity(Pa-s)	Shear rate(Rad/s)
215	26489.98828	1.35367136
215	20322.45117	1.98691798
215	15189.1123	2.916396846
215	10975.2666	4.280685293
215	8272.945313	6.2831852
215	6355.360352	9.222454876

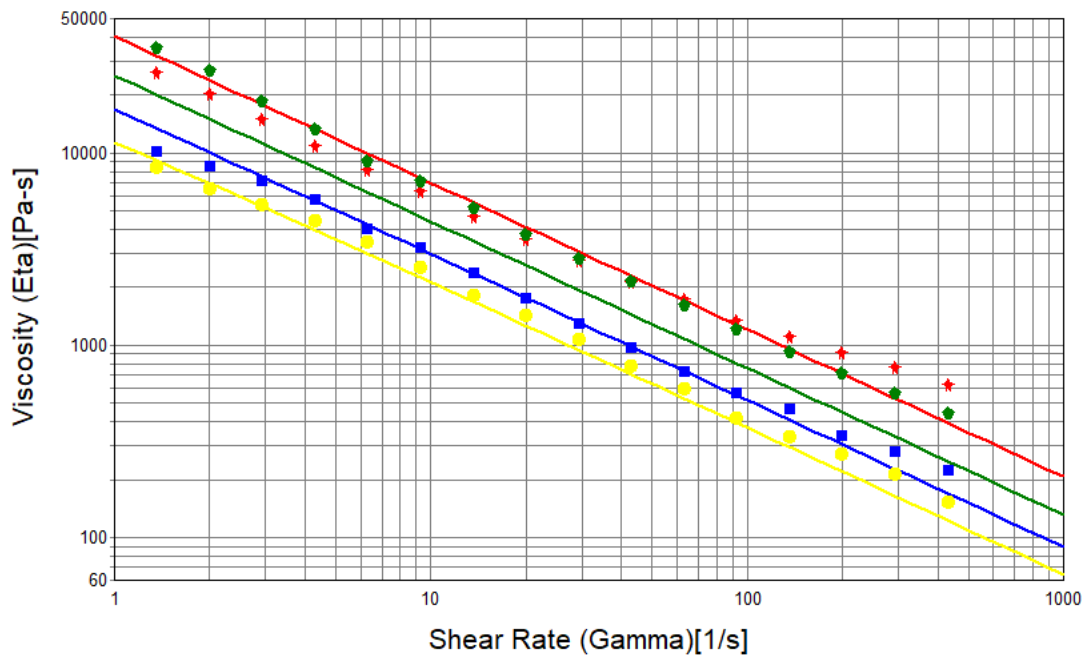
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215	4731.496582	13.5367121
215	3607.22168	19.86917643
215	2790.457031	29.16396434
215	2155.693115	42.80684769
215	1746.385376	62.831852
215	1347.341919	92.22453527
215	1109.697754	135.3670911
215	922.817688	198.6917104
215	776.6151733	291.6395116
215	624.3572998	428.0682132
230	35576.76172	1.35367136
230	27439.80469	1.98691798
230	18804.53516	2.916396846
230	13592.4873	4.280685293
230	9260.404297	6.2831852
230	7190.395996	9.222454876
230	5224.4375	13.5367121
230	3842.742676	19.86917643
230	2851.123047	29.16396434
230	2186.516602	42.80684769
230	1630.834229	62.831852
230	1235.92688	92.22453527
230	939.5891724	135.3670911
230	721.9465332	198.6917104
230	570.8170166	291.6395116
230	446.5094604	428.0682132
245	10218.49121	1.35367136
245	8634.388672	1.98691798
245	7237.01416	2.916396846
245	5751.065918	4.280685293
245	4049.169189	6.2831852
245	3276.699707	9.222454876
245	2395.392334	13.5367121
245	1771.618896	19.86917643
245	1312.741577	29.16396434
245	979.6143799	42.80684769
245	742.7663574	62.831852
245	566.4248657	92.22453527
245	468.3532715	135.3670911
245	343.819519	198.6917104
245	281.2783508	291.6395116
245	224.4502716	428.0682132
260	8466.779297	1.35367136



260	6532.355957	1.98691798
260	5427.57373	2.916396846
260	4452.907715	4.280685293
260	3451.167969	6.2831852
260	2556.120117	9.222454876
260	1822.411255	13.5367121
260	1436.643555	19.86917643
260	1086.054321	29.16396434
260	789.8622437	42.80684769
260	601.9967651	62.831852
260	418.7533875	92.22453527
260	339.184967	135.3670911
260	274.9767151	198.6917104
260	216.4056854	291.6395116
260	154.395462	428.0682132

Temperature (T)[C]= 215    ◆ Temperature (T)[C]= 230    ◆ Temperature (T)[C]= 245    ■ Temperature (T)[C]= 260    ●



## PVT raw data:

**Test standard:** ISO17744

*isobaric cooling 5 °C/min The machine is heated to the processing temperature, keeping in fixed pressure, then cooling to 40 °C at constant rate of 5 °C/min. Measure the volume change at least 4 different pressures.*

**Test instrument:** GOTECH PVT6000 (piston type)

**Test specifications:**

pre-processing	dried at:	100°C 4H
Moisture Level		<0.05%
measure type		isobaric cooling 5° C/min

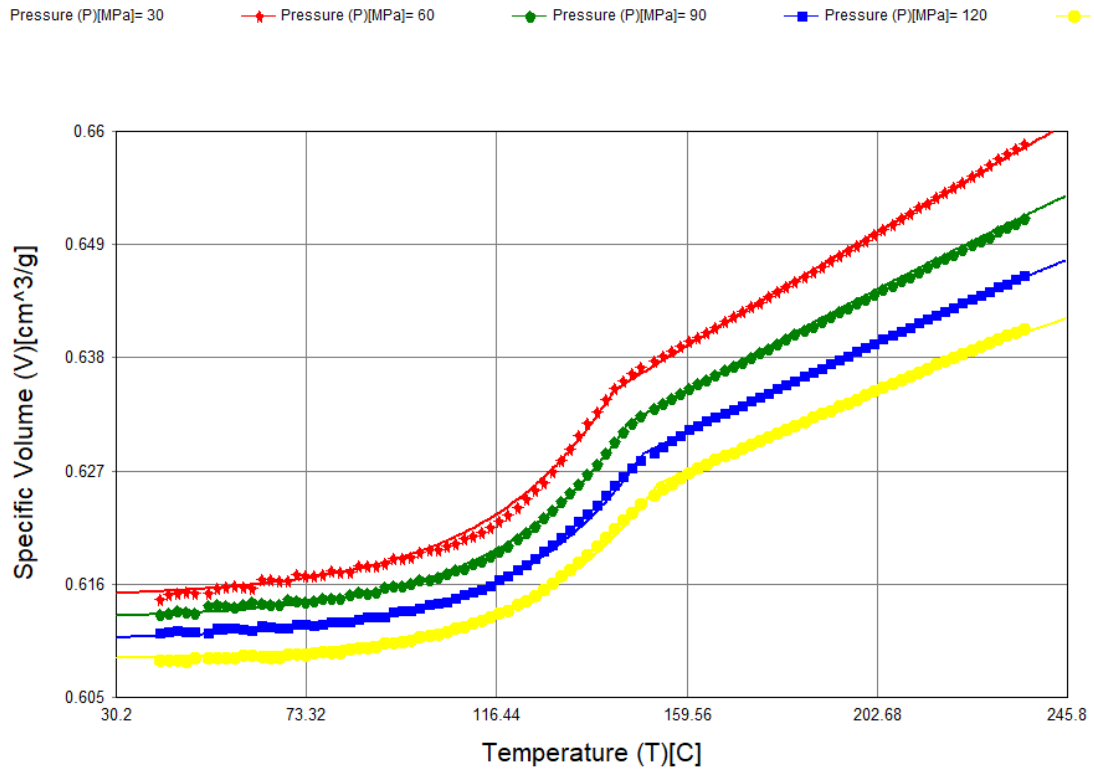
Specific Volume cm <sup>3</sup> /g				
Temperature °C	30	60	90	120
260	0.6646	0.6555	0.6496	0.6441
259	0.6647	0.6556	0.6496	0.6441
257	0.6643	0.6554	0.6494	0.6439
255	0.6637	0.655	0.6491	0.6436
253	0.6632	0.6547	0.6488	0.6434
250	0.6626	0.6543	0.6485	0.6431
248	0.6621	0.6539	0.6481	0.6428
246	0.6616	0.6536	0.6478	0.6425
244	0.6611	0.6532	0.6475	0.6422
242	0.6605	0.6528	0.6471	0.6419
240	0.6599	0.6524	0.6467	0.6415
238	0.6594	0.6519	0.6464	0.6412
236	0.6588	0.6515	0.646	0.6408
234	0.6583	0.6511	0.6456	0.6405
232	0.6578	0.6507	0.6452	0.6402
230	0.6573	0.6503	0.6449	0.6398
228	0.6567	0.6498	0.6445	0.6395
226	0.6562	0.6494	0.6441	0.6391
224	0.6557	0.649	0.6437	0.6388
222	0.6551	0.6486	0.6433	0.6384
220	0.6546	0.6481	0.6429	0.638
218	0.6541	0.6477	0.6425	0.6377
216	0.6536	0.6473	0.6421	0.6374
214	0.653	0.6468	0.6418	0.637
212	0.6526	0.6464	0.6414	0.6366
210	0.652	0.6459	0.641	0.6362
208	0.6515	0.6455	0.6406	0.6359
206	0.651	0.6451	0.6402	0.6355
204	0.6505	0.6447	0.6398	0.6352
202	0.65	0.6442	0.6394	0.6348
200	0.6494	0.6437	0.639	0.6344
198	0.6489	0.6433	0.6386	0.634
196	0.6484	0.6429	0.6382	0.6336
194	0.6479	0.6425	0.6378	0.6333
192	0.6474	0.642	0.6374	0.6329
190	0.6469	0.6416	0.637	0.6326

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188	0.6464	0.6411	0.6366	0.6322
186	0.6459	0.6407	0.6362	0.6318
184	0.6454	0.6403	0.6358	0.6314
182	0.6449	0.6398	0.6354	0.6311
180	0.6444	0.6394	0.635	0.6307
178	0.6439	0.6389	0.6346	0.6303
176	0.6434	0.6385	0.6342	0.63
174	0.643	0.6381	0.6338	0.6296
172	0.6425	0.6376	0.6334	0.6292
170	0.642	0.6372	0.633	0.6288
168	0.6415	0.6368	0.6326	0.6285
166	0.641	0.6363	0.6323	0.6281
164	0.6405	0.6359	0.6319	0.6277
162	0.64	0.6355	0.6314	0.6273
160	0.6396	0.635	0.631	0.6268
158	0.6391	0.6346	0.6305	0.6264
156	0.6386	0.6341	0.63	0.6258
154	0.6382	0.6336	0.6294	0.6253
152	0.6377	0.6331	0.6288	0.6246
149	0.6371	0.6324	0.628	0.6238
147	0.6365	0.6317	0.6273	0.623
145	0.6358	0.6308	0.6265	0.6222
143	0.635	0.6298	0.6256	0.6214
141	0.6339	0.6288	0.6247	0.6206
139	0.6327	0.6277	0.6237	0.6197
137	0.6316	0.6267	0.6229	0.6189
135	0.6304	0.6258	0.6221	0.6182
133	0.6291	0.6249	0.6213	0.6174
131	0.628	0.6241	0.6206	0.6168
129	0.6269	0.6232	0.6198	0.6161
127	0.6259	0.6225	0.6192	0.6155
125	0.6251	0.6217	0.6185	0.6149
123	0.6243	0.621	0.6179	0.6144
121	0.6235	0.6204	0.6174	0.614
119	0.6227	0.6197	0.6168	0.6135
117	0.6221	0.6192	0.6164	0.6132
115	0.6215	0.6187	0.6159	0.6128
113	0.621	0.6183	0.6155	0.6125
111	0.6207	0.618	0.6153	0.6122
109	0.6204	0.6176	0.615	0.6119
107	0.62	0.6174	0.6147	0.6117
105	0.6197	0.6171	0.6143	0.6114
103	0.6194	0.6167	0.6142	0.6111

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101	0.6194	0.6165	0.614	0.611
99	0.6191	0.6164	0.6137	0.6109
97	0.6186	0.6161	0.6134	0.6106
95	0.6185	0.6158	0.6134	0.6104
93	0.6185	0.6158	0.6133	0.6103
91	0.618	0.6157	0.6129	0.6103
89	0.6178	0.6152	0.6128	0.6099
87	0.6178	0.6151	0.6128	0.6098
85	0.6178	0.6152	0.6126	0.6098
83	0.6172	0.615	0.6123	0.6097
81	0.6172	0.6146	0.6124	0.6094
79	0.6173	0.6147	0.6124	0.6094
77	0.617	0.6147	0.6121	0.6095
75	0.6168	0.6144	0.612	0.6093
73	0.6168	0.6143	0.6121	0.6091
71	0.6169	0.6144	0.6121	0.6092
69	0.6163	0.6145	0.6117	0.6092
67	0.6163	0.614	0.6118	0.6089
65	0.6164	0.6141	0.6119	0.6089
63	0.6164	0.6142	0.612	0.609
61	0.6156	0.6143	0.6115	0.6091
59	0.6157	0.6141	0.6116	0.6091
57	0.6158	0.6138	0.6117	0.6088
55	0.6157	0.6139	0.6118	0.6088
53	0.6156	0.614	0.6117	0.6089
51	0.6151	0.6139	0.6113	0.6089
48	0.6151	0.6132	0.6114	0.6088
46	0.6152	0.6133	0.6114	0.6085
44	0.6151	0.6134	0.6115	0.6086
42	0.615	0.6132	0.6114	0.6086
40	0.6145	0.6131	0.6113	0.6086



## Heat Capacity raw data:

**Test standard:** ASTM E1269

*The material is heated to its molten state and then cooled down to 30 °C at a constant rate of 20 °C/min.*

**Test instrument:** NETZSCH DSC 214 Polyma

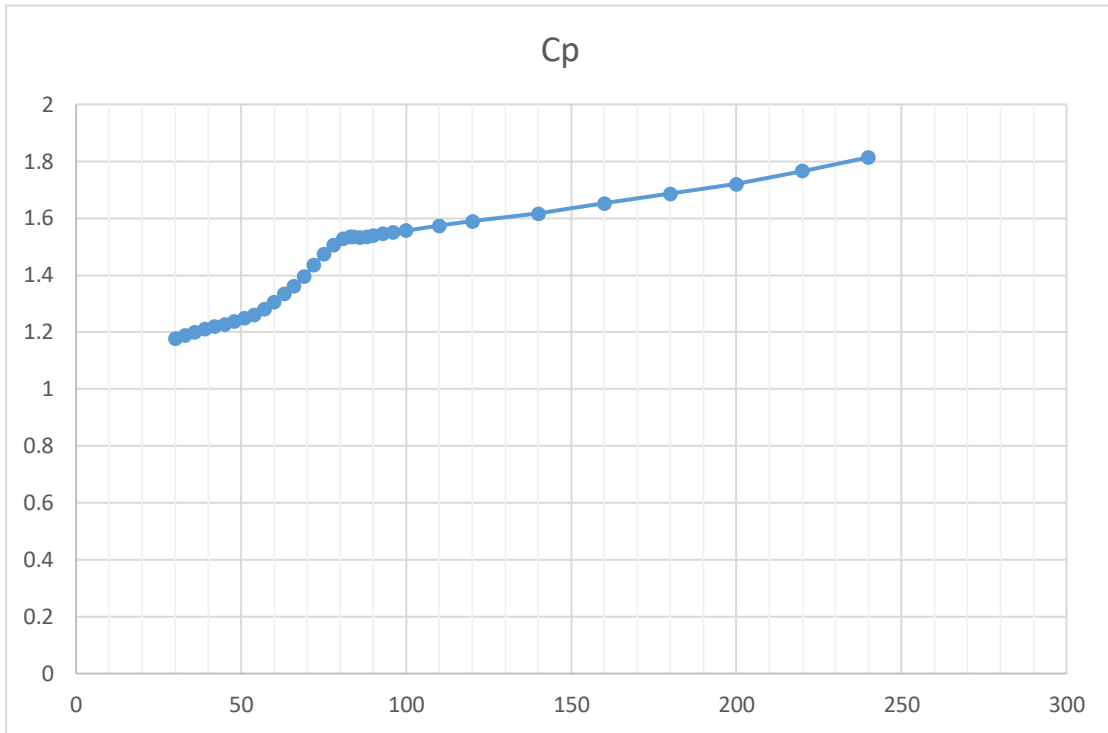
**Test specifications:**

pre-processing	100°C 4H
Moisture Level	<0.05%
Sample weight	20mg
Cooling rate	20°C/min
Purge gas	Nitrogen

Temperature, °C	Cp, J/g K
30	1.1768
33	1.1879
36	1.2008
39	1.21127
42	1.2199
45	1.22789
48	1.23694
51	1.24925
54	1.2607

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57	1.28086
60	1.30664
63	1.33467
66	1.36221
69	1.39534
72	1.43599
75	1.47333
78	1.5062
81	1.52931
83	1.53504
84	1.53424
86	1.53204
88	1.53437
90	1.53999
93	1.54652
96	1.55081
100	1.55711
110	1.57402
120	1.58962
140	1.61692
160	1.65257
180	1.68614
200	1.7203
220	1.76571
240	1.81388



## Thermal conductivity raw data:

**Test standard:** ASTM D 5930

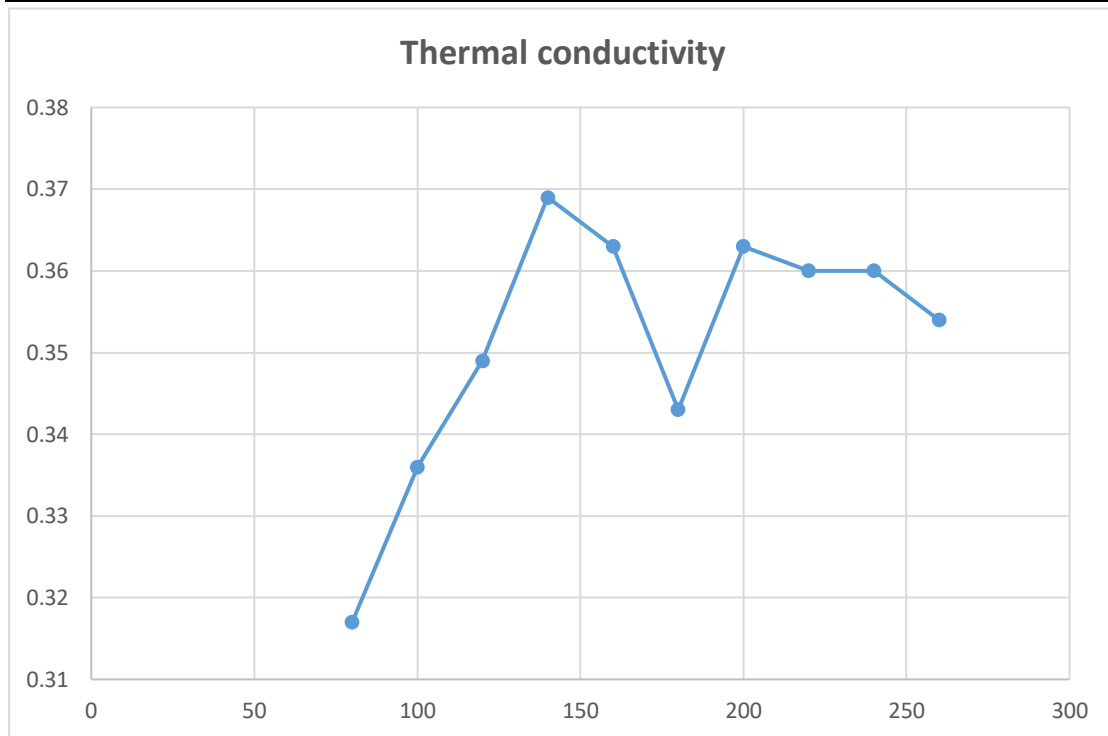
*A line source probe is inserted into the molten polymer, and then the temperature gradient is measured after an applied voltage to the probe at each acquisition temperature.*

**Test instrument:** GOTTFERT RG25

**Test specifications:**

pre-processing	100°C 4H
Moisture Level	<0.05%
Measure type	Isothermal Cooling

Temperature, °C	W/m K
260	0.354
240	0.36
220	0.36
200	0.363
180	0.343
160	0.363
140	0.369
120	0.349
100	0.336
80	0.317



## Mechanical raw data

### Elastic modulus and Poisson's ratio and shear modulus

**Test standard:**

ASTM D 638, Standard Test Method for Tensile Properties of Plastics

ASTM E 132, Standard Test Method for Poisson's Ratio at Room Temperature

**Test instrument:** MTS Universal Testing Machine

**Test specifications:**

Specimens Tested	5(per direction)
Pre-Processing	23°C ± 2°C at 50% ± 5% humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Test Speed:	5mm/min

	1st principal direction[E1] MPa	2nd principal direction[E2] MPa
piece1	11140	5646
piece2	10801	5991
piece3	12456	6748
piece4	11711	5792
piece5	11948	5684

	1st principal direction[V12]	2nd principal direction[V23]
piece1	0.47	0.41



piece2	0.45	0.49
piece3	0.46	0.46
piece4	0.46	0.45
piece5	0.47	0.49

Shear modulus [G12] MPa	2370.41
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## Coefficient of linear thermal expansion

**Test standard:** ASTM E831:2012

**Test instrument:** NETZSCH TMA 402 F3 Hyperion

**Test specifications:**

Specimens Tested:	3(per direction)
Pre-Processing:	23°C ± 2°C at 50% ± 5% humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Specimen Geometry:	10mm x 10mm x 3.0mm
Temperature Range:	25°C to 85°C

	Alpha 1	Alpha 2
piece1	1.2920E-05	3.4255E-05
piece2	1.2091E-05	3.2830E-05
piece3	1.2507E-05	3.1056E-05

## Contact details

### Contact Information

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