

# **Material Testing Report**

**SN 7468**

**ISOFIL HK 50 2FH0 NA3**

Prepared for:

**SIRMAX SPA**

**Via Dell'Artigianato 42**

**Cittadella, 35013**

**Italy**

Prepared by:

**Autodesk Moldflow Plastics Labs**

**2353 N. Triphammer Rd.**

**Ithaca, NY 14850**

**USA**

Prepared on:

**22 May, 2015**

Report Authorized By:



Andrew Kostuk

Laboratory Technician

22 May, 2015

© Autodesk 2015. This report may not be reproduced.

Test results relate only to the item tested. Autodesk disclaims all warranties express or implied, including warranties of merchantability and fitness for a particular purpose. Autodesk expressly disclaims all incidental and consequential damages that may arise from the use of this information.



**Testing Cert. 2399.01**

Moldflow Plastics Labs is accredited by the American Association for Laboratory Accreditation, and maintains a quality system in accordance with ISO/IEC 17025. Tests performed outside the scope of accreditation are duly noted.

# Contents

---

Summary .....	4
Viscosity .....	9
Thermal conductivity .....	15
Specific heat .....	17
Pressure-Volume-Temperature .....	19
Shrinkage .....	22
Mechanical .....	28
Elastic modulus and Poisson's ratio .....	28
Shear modulus .....	29
Coefficient of linear thermal expansion .....	30
Mold verification .....	31
Contact details .....	35

## Summary

### Description

Family name	POLYPROPYLENES (PP)
Trade name	ISOFIL HK 50 2FH0 NA3
Manufacturer	Sirmax SpA
Family abbreviation	PP
Material structure	Crystalline
Data source	Autodesk Moldflow Plastics Labs : pvT-Measured : mech-Measured
Date last modified	21-MAY-15
Date tested	21-MAY-15
Data status	Non-Confidential
Material ID	31773
Grade code	SN7468
Supplier code	SIRMAX
Fibers/fillers	50% Calcium Carbonate Filled

### Recommended Processing

Mold surface temperature	45	°C
Melt temperature	238	°C

<b>Mold temperature range (recommended)</b>		
Minimum	30	°C
Maximum	60	°C

<b>Melt temperature range (recommended)</b>		
Minimum	220	°C
Maximum	255	°C

Absolute maximum melt temperature	300	°C
-----------------------------------	-----	----

Ejection temperature	113	°C
----------------------	-----	----

Maximum shear stress	0.25	MPa
Maximum shear rate	100000	1/s

**Maximum shear stress and maximum shear rate values have been supplemented with generic estimates.**

## Rheological Properties

<b>Cross WLF Viscosity Model</b>		
n	0.3117	
Tau	36106.3	Pa
D1	3.46789e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	31.885	
A2	51.600	K

<b>Juncture loss method coefficients</b>		
C1	8.784e-007	Pa <sup>(1-c2)</sup>
C2	2.29	

<b>Transition temperature</b>		
Ttrans	121	°C

Moldflow Viscosity Index	VI(240)97	
--------------------------	-----------	--

<b>Melt mass-flow rate (MFR)</b>		
Temperature	230	°C
Load	2.16	Kg
Measured MFR	18.0	g/10min

### Thermal Properties

<b>Specific heat data</b>		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
248	1969.0	-0.33
208	1842.0	-0.33
168	1763.0	-0.33
128	1694.0	-0.33
121	2601.0	-0.33
117	10099.0	-0.33
113	3303.0	-0.33
108	1826.0	-0.33
92	1618.0	-0.33
72	1489.0	-0.33
54	1377.0	-0.33

<b>Thermal conductivity data</b>		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
260.5	0.278	0.0
239.2	0.271	0.0
218	0.269	0.0
196.9	0.274	0.0
176.1	0.274	0.0
155.2	0.274	0.0
136.9	0.332	0.0
114.7	0.388	0.0
93.9	0.402	0.0
73.1	0.419	0.0
52.1	0.419	0.0
31.2	0.432	0.0

### PVT Properties

Melt density	1.1680	g/cm <sup>3</sup>
Solid density	1.3631	g/cm <sup>3</sup>

#### 2-domain Tait PVT model coefficients

b5	438.15	K
b6	8.401e-008	K/Pa
b1m	0.000823	m <sup>3</sup> /Kg
b2m	4.561e-007	m <sup>3</sup> /Kg-K
b3m	1.20699e+008	Pa
b4m	0.003995	1/K
b1s	0.000764	m <sup>3</sup> /Kg
b2s	2.174e-007	m <sup>3</sup> /Kg-K
b3s	2.51314e+008	Pa
b4s	0.003859	1/K
b7	0.000059	m <sup>3</sup> /Kg
b8	0.078784	1/K
b9	1.132e-008	1/Pa

### Mechanical Properties

#### Mechanical properties data

Elastic modulus, 1 <sup>st</sup> principal direction [E1]	2687	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	2572	MPa
Poisson's ratio [v12]	0.4240	
Poisson's ratio [v23]	0.4240	
Shear modulus [G12]	876	MPa

#### Transversely isotropic coefficient of thermal expansion [CTE] data

Alpha1	8.290e-005	1/°C
Alpha2	9.120e-005	1/°C

### Shrinkage Properties

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.751182
A2	-0.0795
A3	0.006505
A4	1.298865
A5	-0.5000
A6	0.006325

Residual strain model coefficients		
	Parallel	Perpendicular
A1	0.054942	0.13584
A2	0.000074	0.001375
A3	-0.000193	-0.000329
A4	6.3834e-008	2.4077e-007
A5	0.007906	0.007608

**The shrinkage models shown above are valid for Autodesk Simulation Moldflow Insight 2015.  
Shrinkage models for previous software versions are included in the 21000.udb file.**

### Filler Properties

Filler data	
Description	Weight %
Calcium Carbonate	50



# Viscosity

## Method:

MPL Test Method

(Method falls outside the scope of A2LA Accreditation)

## Instrument:

Arburg Allrounder 270S Injection Molding Machine

## Test Specifications:

Sample Form:	Pellets
Pre-Processing:	Dried at 70°C for 1 hour in a hopper dryer
Moisture Level:	Not measured
Capillary A: Length:	32.3889 mm
L/D:	16.19445
Die Entry Angle:	90 degrees
Capillary B: Length:	8.0249 mm
L/D:	4.01245
Die Entry Angle:	90 degrees
Barrel Diameter:	30 mm
Plastication Time:	20 sec
Dwell Time:	20 sec
Corrections:	Bagley, Rabinowitsch and shear heating
Date Received:	11-MAR-15
Date Tested:	28-APR-15

## Operator's Notes:

Testing was performed per standard testing procedures.

No anomalies were noted during the course of testing.

## Apparent Viscosity Data

Temperature (°C)	Apparent Shear Rate (sec <sup>-1</sup> )	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
198.9	772	190.98	2	16.19
199.1	1351	133	2	16.19
199.3	195	448.75	2	16.19
199.3	314	335.2	2	16.19
199.7	25701	21.25	2	16.19
199.7	64988	14.71	2	16.19
200	2607	85.94	2	16.19
200.4	12833	30.9	2	16.19
200.5	6514	46.85	2	16.19
219.3	196	377.48	2	16.19
219.7	772	160.98	2	16.19
219.7	1351	111.95	2	16.19
219.7	12829	25.08	2	16.19
219.7	25712	16.41	2	16.19
219.7	65018	9.93	2	16.19
219.9	2604	72.34	2	16.19
220.1	316	281.16	2	16.19
220.3	6509	39.13	2	16.19
239.7	195	325.56	2	16.19
239.8	315	244.49	2	16.19
239.8	772	141.82	2	16.19
239.9	2605	64.11	2	16.19
239.9	64958	8.12	2	16.19
240	1354	98.77	2	16.19
240.7	6514	34.36	2	16.19
240.8	25724	13.97	2	16.19
240.9	12828	21.87	2	16.19
260.3	196	282.82	2	16.19
260.4	1352	88.42	2	16.19
260.4	2604	57.85	2	16.19
260.5	6508	31.26	2	16.19
260.8	316	214.17	2	16.19
260.8	771	125.62	2	16.19
260.8	64864	7.05	2	16.19
261.2	12827	19.7	2	16.19
261.7	25727	12.43	2	16.19
198	314	342.56	2	4.01
198.2	195	433	2	4.01
198.3	772	212.31	2	4.01
198.4	12833	44.18	2	4.01
199	1351	155.46	2	4.01
199	25701	31.1	2	4.01
199.6	6514	63.6	2	4.01
199.7	2607	106.33	2	4.01
199.9	64988	17.66	2	4.01
218.9	25712	25.4	2	4.01
219.9	196	328.78	2	4.01
219.9	65018	15.84	2	4.01
220	1351	125.16	2	4.01
220	2604	86.86	2	4.01
220.1	772	168.3	2	4.01

Temperature (°C)	Apparent Shear Rate (sec <sup>-1</sup> )	Apparent Viscosity (Pa-s)	Die Diameter (mm)	Die L/D
220.2	316	262.29	2	4.01
220.2	6509	52.07	2	4.01
220.3	12829	36.23	2	4.01
239.3	12828	30.55	2	4.01
239.8	6514	44.19	2	4.01
240	195	266.04	2	4.01
240	772	141.32	2	4.01
240	25724	21.18	2	4.01
240	64958	13.33	2	4.01
240.1	315	215.6	2	4.01
240.3	1354	105.21	2	4.01
240.4	2605	73.66	2	4.01
260	316	176.56	2	4.01
260	12827	26.38	2	4.01
260	25727	18.16	2	4.01
260	64864	11.42	2	4.01
260.1	771	118.71	2	4.01
260.4	1352	89.87	2	4.01
260.6	6508	38.3	2	4.01
260.7	196	214.36	2	4.01
260.9	2604	63.56	2	4.01

### Calculated Viscosity Data

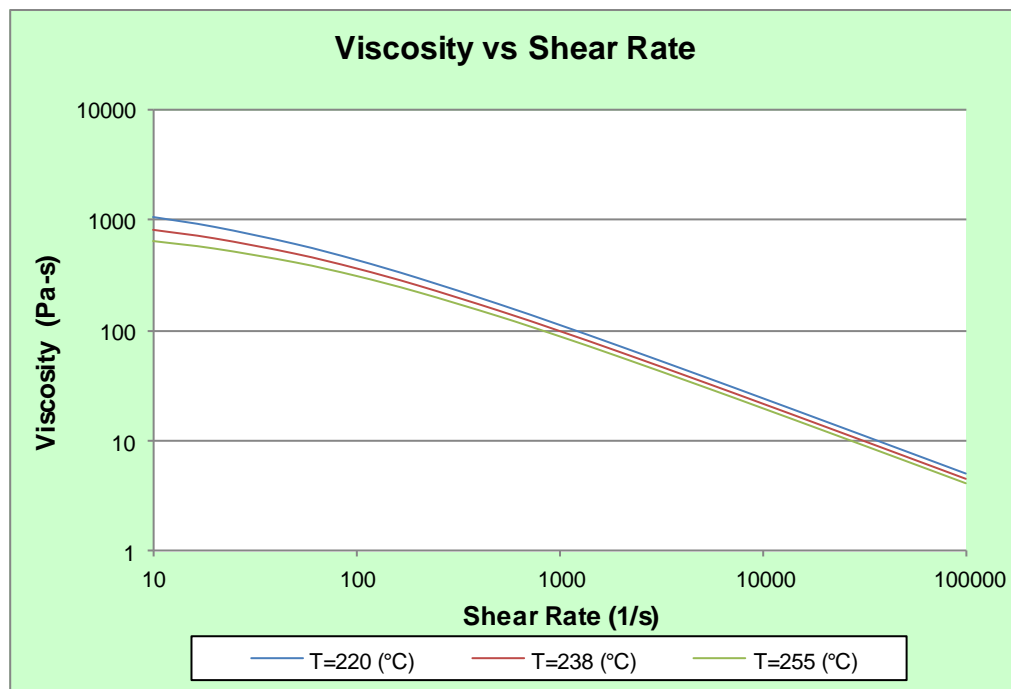
Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
198	314	279.42
198.2	195	372.59
198.3	772	157.33
198.4	12833	23.87
198.9	772	156.53
199	25701	14.78
199	1351	108.39
199.1	1351	108.31
199.3	195	368.58
199.3	314	276.08
199.6	6514	37.53
199.7	2607	69.57
199.7	25701	14.7
199.7	64988	7.79
199.9	64988	7.77
200	2607	69.41
200.4	12833	23.51
200.5	6514	37.27
218.9	25712	12.83
219.3	196	304.47
219.7	1351	92.39
219.7	12829	20.5
219.7	25712	12.76
219.7	65018	6.76
219.7	772	132.44
219.9	65018	6.75
219.9	196	302.82
219.9	2604	59.91
220	2604	59.87
220	1351	92.19
220.1	772	132.04
220.1	316	229.03
220.2	316	228.84
220.2	6509	32.36
220.3	12829	20.42
220.3	6509	32.34
239.3	12828	18.14
239.7	195	255.63
239.8	772	114.55
239.8	6514	28.57
239.8	315	195.76
239.9	2605	52.51
239.9	64958	5.98
240	1354	80.26
240	195	254.98
240	772	114.39
240	25724	11.26
240	64958	5.98
240.1	315	195.3
240.3	1354	80.1
240.4	2605	52.35

Temperature (°C)	Shear Rate (sec <sup>-1</sup> )	Calculated Viscosity (Pa-s)
240.7	6514	28.42
240.8	25724	11.21
240.9	12828	17.97
260	12827	16.19
260	25727	10.1
260	64864	5.38
260	316	168.04
260.1	771	100.31
260.3	196	215.72
260.4	1352	70.8
260.4	1352	70.8
260.4	2604	46.56
260.5	6508	25.45
260.6	6508	25.44
260.7	196	215.04
260.8	771	99.87
260.8	316	167.08
260.8	64864	5.35
260.9	2604	46.43
261.2	12827	16.09
261.7	25727	10.01

### Rheological Data

Cross WLF Viscosity Model		
n	0.3117	
Tau	36106.3	Pa
D1	3.46789e+014	Pa-s
D2	263.15	K
D3	0	K/Pa
A1	31.885	
A2	51.600	K

Juncture loss method coefficients		
C1	8.784e-007	Pa <sup>(1-c2)</sup>
C2	2.29	



# Thermal conductivity

**Method:**

ASTM D 5930, Standard Test Method for Thermal Conductivity of Plastics by Means of a Transient Line-Source Technique.  
(Method falls outside the scope of A2LA Accreditation)

**Instrument:**

Moldflow K-System II

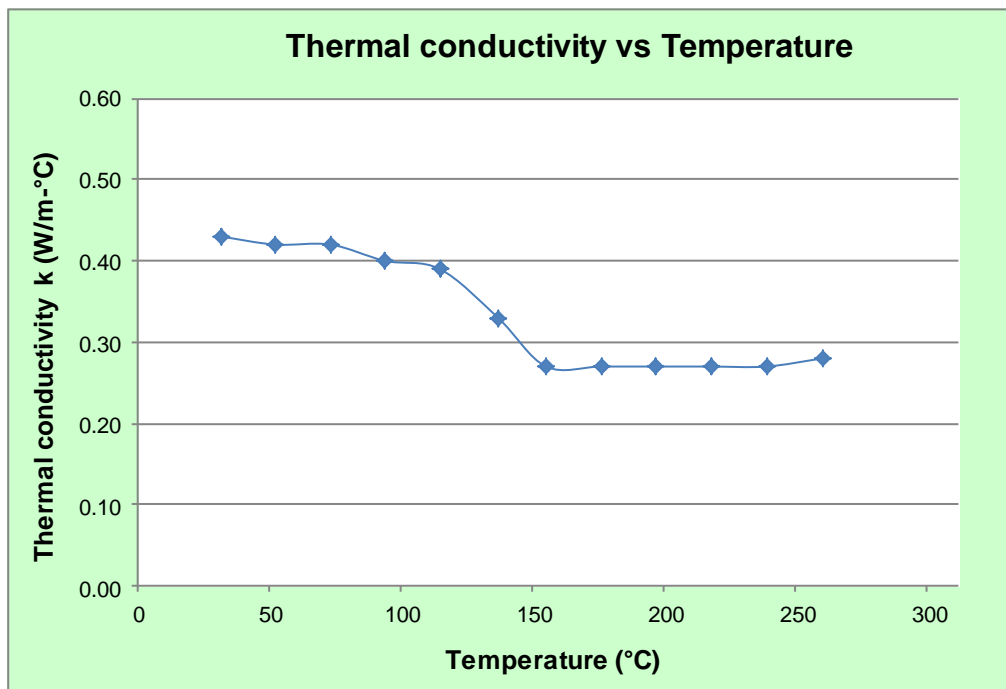
**Test Specifications:**

Sample Form:	Pellets
Pre-Processing:	Dried at 70°C for 1 hour in a hopper dryer
Moisture Level:	Not measured
Probe Constant:	0.784
Probe Length:	50 mm
Data acquisition time:	45 sec
Probe Voltage:	4.0 V
Date Received:	11-MAR-15
Date Tested:	07-MAY-15

**Operator's Notes:**

Testing was performed at our Kilsyth site per standard testing procedures.  
No anomalies were noted during the course of testing.

Thermal conductivity data		
Temperature (T) °C	Thermal conductivity (k) W/m-°C	Heating/Cooling rate °C/s
260.5	0.278	0.0
239.2	0.271	0.0
218	0.269	0.0
196.9	0.274	0.0
176.1	0.274	0.0
155.2	0.274	0.0
136.9	0.332	0.0
114.7	0.388	0.0
93.9	0.402	0.0
73.1	0.419	0.0
52.1	0.419	0.0
31.2	0.432	0.0





# Specific heat

## Method:

ASTM E 1269, Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry

ASTM D 3418, Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry

## Instrument:

Perkin Elmer Pyris Diamond Differential Scanning Calorimeter

## Test Specifications:

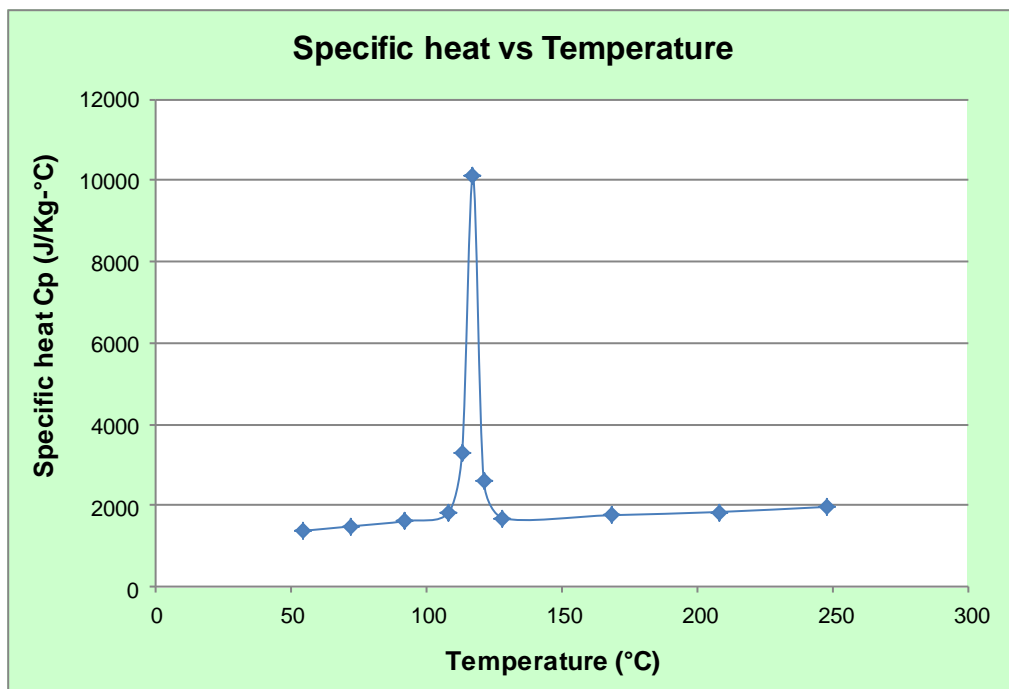
Sample Form:	Pellets
Pre-Processing:	Dried at 70°C for 1 hour in a hopper dryer
Moisture Level:	Not measured
Initial Temperature:	255°C
Final Temperature:	40°C
Cooling Rate:	20°C/min
Equilibrium Time:	3 min
Sample holder material:	Aluminum
Sample holder dimensions:	6.7 mm diameter, 1.6 mm tall
Sample holder mass:	25 mg (pan + lid)
Purge gas:	99.99% pure nitrogen
Purge gas flow rate:	30 cm <sup>3</sup> /sec
Date Received:	11-MAR-15
Date Tested:	28-APR-15

## Operator's Notes:

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

Specific heat data		
Temperature (T) °C	Specific heat (Cp) J/Kg-°C	Heating/Cooling rate °C/s
248	1969.0	-0.33
208	1842.0	-0.33
168	1763.0	-0.33
128	1694.0	-0.33
121	2601.0	-0.33
117	10099.0	-0.33
113	3303.0	-0.33
108	1826.0	-0.33
92	1618.0	-0.33
72	1489.0	-0.33
54	1377.0	-0.33

T <sub>trans</sub>	121	°C
Ejection temperature	113	°C



# Pressure-Volume-Temperature

**Method:**

High Pressure Indirect Dilatometry

**Instrument:**

Gnomix pVT Apparatus

**Test Specifications:**

Sample Form:	Molded Plaque
Pre-Processing:	Not required
Scan type:	Isothermal Cooling
Date Received:	11-MAR-15
Date Tested:	01-MAY-15

**Operator's Notes:**

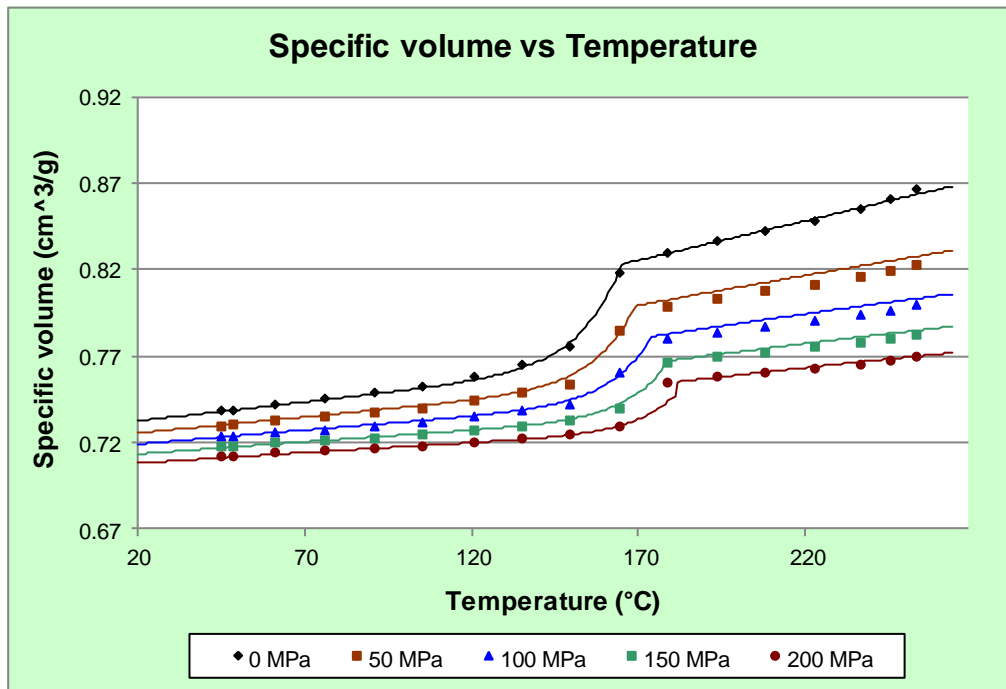
Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.

### pvT Experimental Data

Temperature (°C)	Pressure (MPa)				
	0MPa	50MPa	100MPa	150MPa	200MPa
44.61	0.7380	0.7298	0.7232	0.7175	0.7123
48.32	0.7389	0.7303	0.7235	0.7177	0.7124
61.14	0.7417	0.7326	0.7256	0.7196	0.7142
75.93	0.7449	0.7349	0.7274	0.7212	0.7155
90.83	0.7483	0.7372	0.7293	0.7227	0.7167
105.5	0.7523	0.7399	0.7313	0.7242	0.7181
120.5	0.7583	0.7441	0.7347	0.7271	0.7205
135.1	0.7646	0.7483	0.7379	0.7297	0.7226
149.5	0.7748	0.7539	0.7417	0.7326	0.7249
164.2	0.8181	0.7841	0.7601	0.7396	0.7289
178.6	0.8295	0.7987	0.7803	0.7665	0.7548
193.6	0.8359	0.8030	0.7838	0.7695	0.7578
208.0	0.8419	0.8071	0.7870	0.7723	0.7602
222.8	0.8485	0.8112	0.7903	0.7751	0.7628
237.0	0.8555	0.8157	0.7939	0.7781	0.7655
245.9	0.8608	0.8191	0.7964	0.7804	0.7675
253.6	0.8660	0.8227	0.7991	0.7827	0.7697

Melt density	1.1680	g/cm <sup>3</sup>
Solid density	1.3631	g/cm <sup>3</sup>

2-domain Tait PVT model coefficients		
b5	438.15	K
b6	8.401e-008	K/Pa
b1m	0.000823	m <sup>3</sup> /Kg
b2m	4.561e-007	m <sup>3</sup> /Kg-K
b3m	1.20699e+008	Pa
b4m	0.003995	1/K
b1s	0.000764	m <sup>3</sup> /Kg
b2s	2.174e-007	m <sup>3</sup> /Kg-K
b3s	2.51314e+008	Pa
b4s	0.003859	1/K
b7	0.000059	m <sup>3</sup> /Kg
b8	0.078784	1/K
b9	1.132e-008	1/Pa



# Shrinkage

## Method:

MPL Shrinkage Test Method (QOP-17-M)  
(Method falls outside the scope of A2LA Accreditation)

## Instrument:

Krauss Maffei KM160-750CX Injection molding machine  
Test mold inscribed with a fine grid pattern  
Temperature and Humidity Controlled Room  
OGP Smartscope Flash 400 metrology system

## Test Specifications:

Sample Form:	Pellets
Pre-Processing:	Dried at 70°C for 1 hour in a hopper dryer
Moisture Level:	Not measured
Date Molded:	28-APR-15
Post-Processing:	Conditioned at 23°C / 50% relative humidity for 7 days
Date Measured:	05-MAY-15
Shrinkage Data Correlated With:	Autodesk Simulation Moldflow Insight 2015
Default Model:	Residual Stress (CRIMS)
Date Received:	11-MAR-15

## Operator's Notes:

Testing was performed per standard testing procedures.  
No anomalies were noted during the course of testing.  
Shrinkage measurements have been corrected to account for mold thermal expansion.  
Data for some process conditions may have been removed in the determination of the favored model.

### Shrinkage Experimental Data

Process Condition	Melt Temperature (°C)	Mold Temperature (°C)	Flow Rate (cc/sec)	Part Thickness (mm)	Packing Pressure (MPa)	Packing Time (sec)	Cooling Time (sec)
1	236.3	50.3	40.9	3	18.1	16	10
2	235.7	47.8	40.9	3	37.0	16	10
3	235.7	55.3	40.9	3	56.0	16	10
4	235.4	46.9	19.0	3	36.8	16	10
5	235.3	52.4	60.1	3	37.1	16	10
6	235.7	51.4	27.2	1.5	18.1	10	10
7	235.7	50.4	27.2	1.5	46.6	10	10
8	235.7	52.8	26.4	1.5	75.2	10	10
9	235.6	44.5	14.2	1.5	46.5	10	10
10	235.6	47.3	43.3	1.5	46.7	10	10
11	234.8	51.2	37.4	2	18.1	10	10
12	235.1	53.4	35.3	2	46.5	10	10
13	235.1	54.9	35.3	2	75.1	10	10
14	235.1	55.6	16.9	2	46.3	10	10
15	235.2	57.3	52.9	2	46.7	10	10
16	219.8	54.4	37.4	2	18.1	10	10
17	220.4	54.0	36.3	2	46.7	10	10
18	220.8	48.6	34.3	2	75.5	10	10
19	220.5	50.4	16.9	2	46.5	10	10
20	220.5	56.3	52.9	2	46.8	10	10
21	251.7	52.5	35.3	2	18.2	10	10
22	252.1	47.6	35.3	2	46.8	10	10
23	252.0	54.4	34.3	2	75.6	10	10
24	251.9	52.7	16.9	2	46.6	10	10
25	252.0	47.2	55.2	2	47.0	10	10

### Part Shrinkage

Process Condition	Average Measured Parallel	Average Measured Perpendicular	Average Predicted Volumetric
1	1.144%	1.596%	4.075%
2	1.018%	1.228%	2.656%
3	0.907%	1.064%	1.906%
4	1.039%	1.245%	2.688%
5	1.020%	1.282%	2.648%
6	1.152%	1.364%	7.122%
7	1.063%	1.174%	3.962%
8	0.924%	0.979%	2.344%
9	1.088%	1.089%	3.860%
10	1.002%	1.122%	4.081%
11	1.132%	1.509%	5.468%
12	1.039%	1.244%	2.920%
13	0.832%	0.921%	1.685%
14	1.086%	1.199%	2.868%
15	1.026%	1.175%	2.911%
16	1.200%	1.535%	5.590%
17	1.047%	1.217%	2.961%
18	0.858%	0.894%	1.713%
19	1.116%	1.253%	2.921%
20	1.053%	1.141%	2.950%
21	1.152%	1.553%	5.274%
22	1.009%	1.175%	2.876%
23	0.817%	0.918%	1.614%
24	1.049%	1.197%	2.805%
25	0.968%	1.117%	2.863%



### Residual Stress Coefficients

Corrected residual in-mold stress (CRIMS) model coefficients	
A1	0.751182
A2	-0.0795
A3	0.006505
A4	1.298865
A5	-0.5000
A6	0.006325

### Residual Strain Coefficients

Parallel				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.054942	0.012228	0.086793	0.033104
2	0.000074	0.003637	0.35201	0.092154
3	-0.000193	0.91761	12.896	4.0126
4	6.3834e-008	6492.80	42056.00	20943.00
5	0.007906	0	0	0

Perpendicular				
	Coefficient	Lower Limit	Upper Limit	Centroid
1	0.13584	0.012228	0.06907	0.032032
2	0.001375	0.003637	0.35201	0.092454
3	-0.000329	0.91761	12.896	4.0229
4	2.4077e-007	3139.50	8427.50	4991.10
5	0.007608	0	0	0

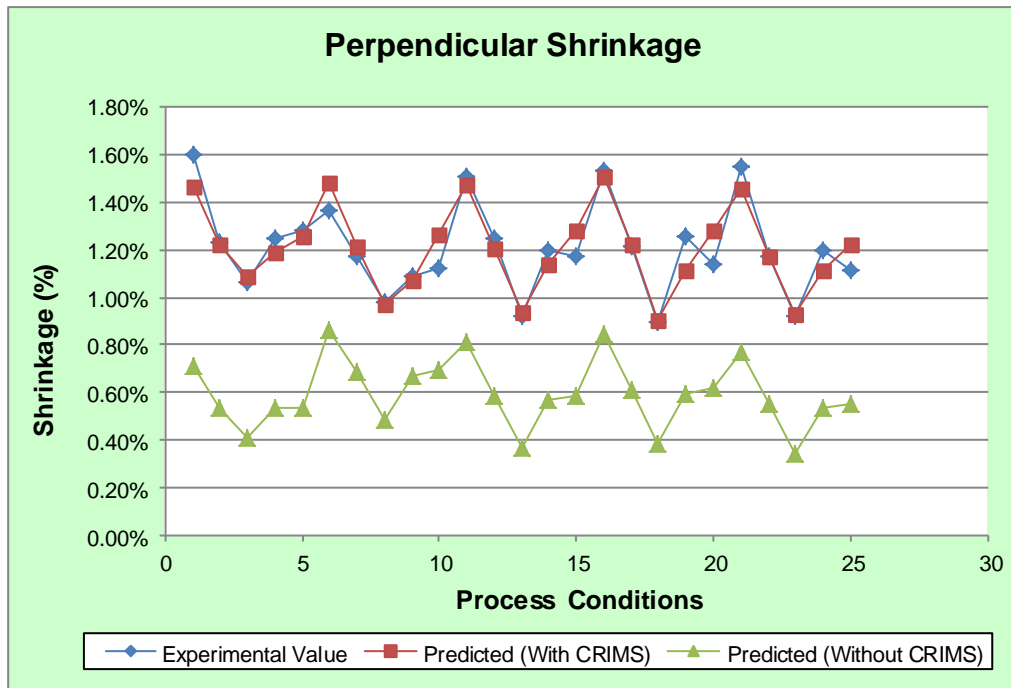
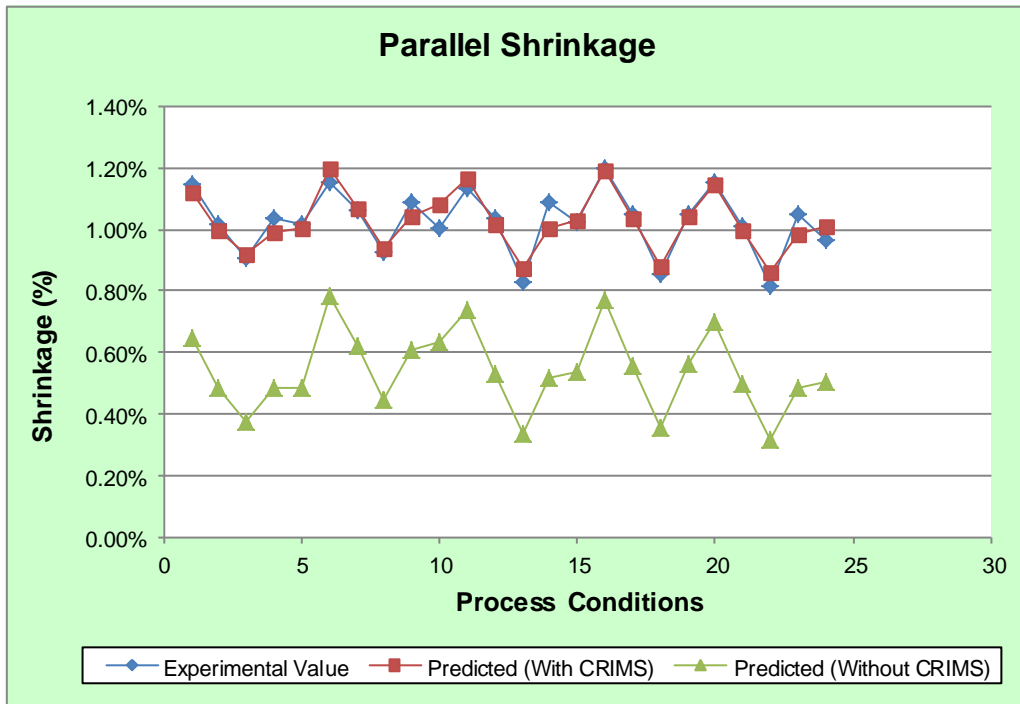
**The shrinkage models shown above are valid for Autodesk Simulation Moldflow Insight 2015.  
Shrinkage models for previous software versions are included in the 21000.udb file.**

### Observed Shrinkage

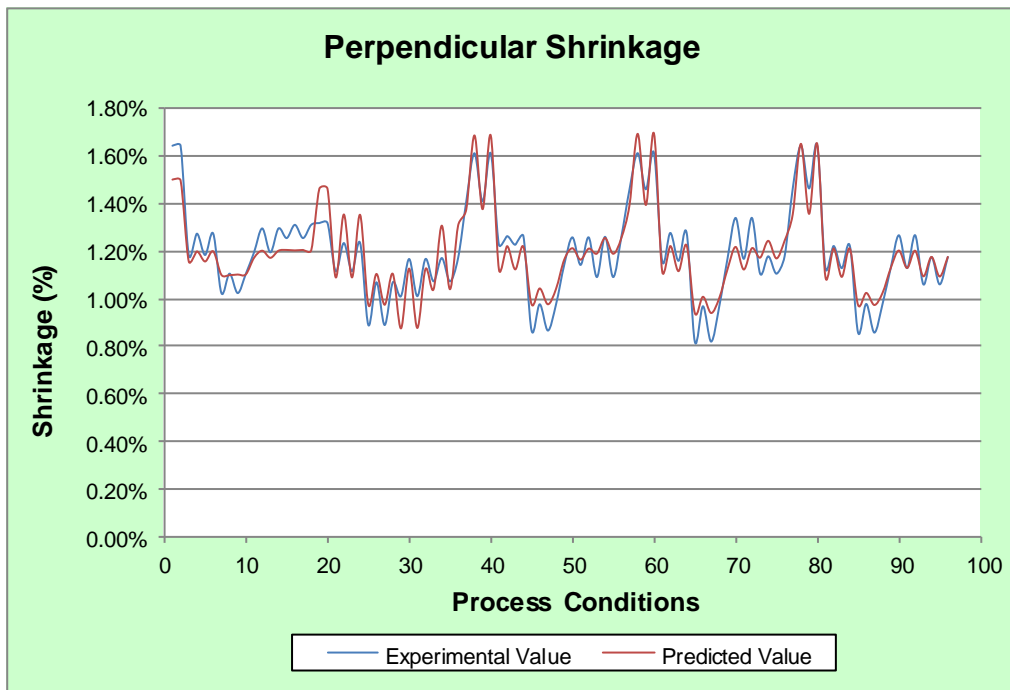
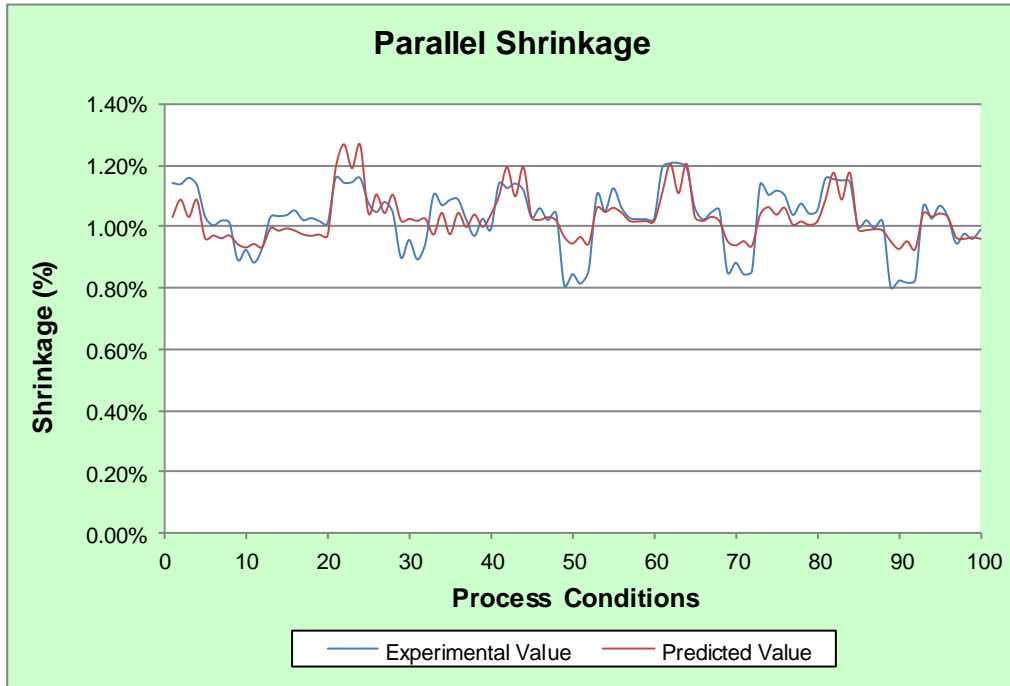
Observed nominal shrinkage	
Parallel	1.030%
Perpendicular	1.208%

Observed shrinkage	
Minimum Parallel	0.817%
Maximum Parallel	1.200%
Minimum Perpendicular	0.894%
Maximum Perpendicular	1.596%

### Residual Stress Plots



### Residual Strain Plots



# Mechanical

## Elastic modulus and Poisson's ratio

### Method:

ASTM D 638, Standard Test Method for Tensile Properties of Plastics  
 ASTM E 132, Standard Test Method for Poisson's Ratio at Room Temperature

### Instrument:

MTS Sintech 5/G Universal Testing Machine

### Test Specifications:

Specimens Tested:	8
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Test Speed:	5 mm/min
Date Received:	11-MAR-15
Date Tested:	1-MAY-15

### Operator's Notes:

Testing was performed per standard testing procedures.

No anomalies were noted during testing.

\*\*NOTE: measured values for v23 were higher than expected; based on other data v23 was set equal to v12.

Elastic modulus		
Elastic modulus, 1 <sup>st</sup> principal direction [E1]	2687	MPa
Elastic modulus, 2 <sup>nd</sup> principal direction [E2]	2572	MPa

Poisson's ratio		
Poisson's ratio [v12]	0.4240	
Poisson's ratio [v23]	0.4240	



## Shear modulus

### Method:

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

### Instrument:

MTS Sintech 5/G Universal Testing Machine

### Test Specifications:

Specimens Tested:	8
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Test Speed:	5 mm/min
Date Received:	11-MAR-15
Date Tested:	1-MAY-15

### Operator's Notes:

Shear modulus is calculated using orthotropic elasticity from the tensile modulus measured on a sample cut at an angle of 45° with the flow direction.

Testing was performed per standard testing procedures.

No anomalies were noted during testing.

Shear modulus		
Shear modulus [G12]	876	MPa



Testing Cert. 2399.01

## Coefficient of linear thermal expansion

### Method:

QOP-11, Coefficient of Linear Thermal Expansion of Plastics

### Instrument:

Quartz tube dilatometer per ASTM

### Test Specifications:

Specimens Tested:	2 (per direction): test repeated 2 times per specimen
Pre-Processing:	23°C +/-2°C at 50% +/-5% relative humidity for a minimum of 40 hours
Sample Form:	Machined from molded plaques
Specimen Geometry:	Rectangular, 8mm x 50mm, full thickness
Temperature Range:	0°C to 60°C
Date Received:	11-MAR-15
Date Tested:	1-MAY-15

### Operator's Notes:

Testing was performed per standard testing procedures.  
No anomalies were noted during testing.

Transversely isotropic coefficient of thermal expansion [CTE] data		
Alpha 1	8.290e-005	1/°C
Alpha 2	9.120e-005	1/°C



# Mold verification

**Method:**

MPL Mold Verification Test Method (QOP-16-M)  
(Method falls outside the scope of A2LA Accreditation)

**Instrument:**

Krauss Maffei KM160-750CX Injection Molding Machine

**Test Specifications:**

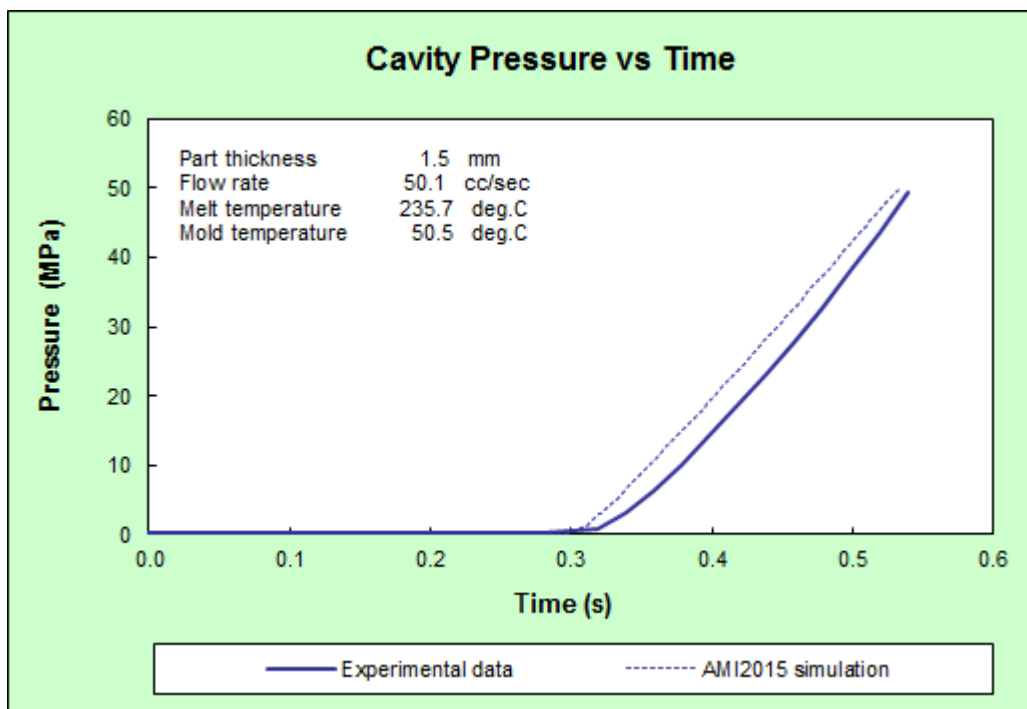
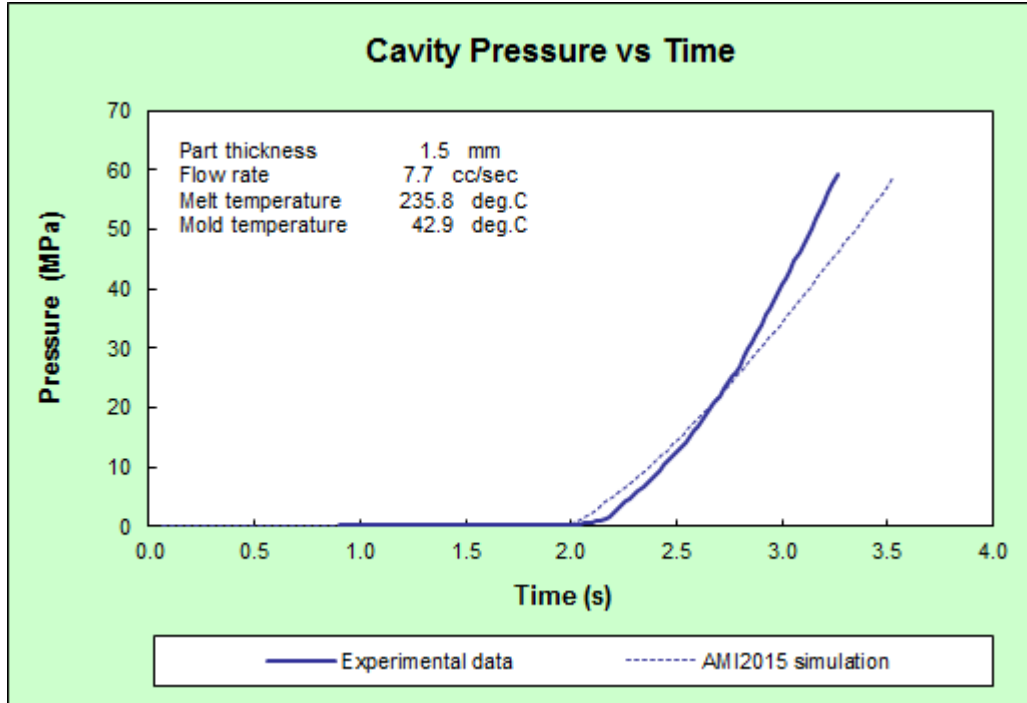
Sample Form:	Pellets
Pre-Processing:	Dried at 70°C for 1 hour in a hopper dryer
Moisture Level:	Not measured
Date Received:	11-MAR-15
Date Tested:	28-APR-15

**Operator's Notes:**

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

**1.5mm tag die**

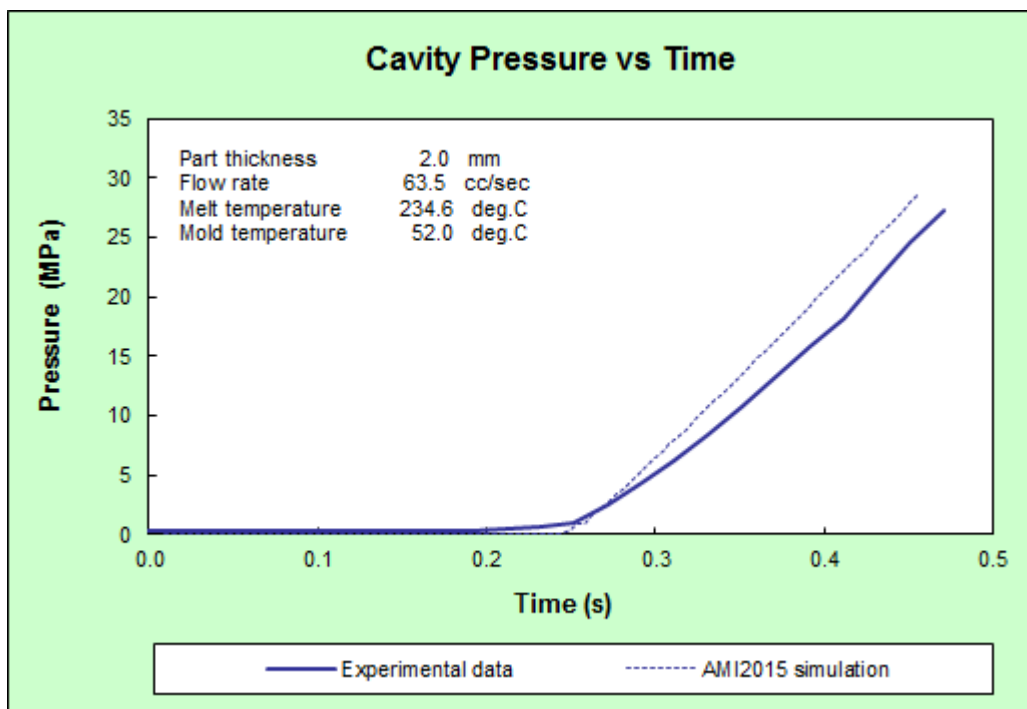
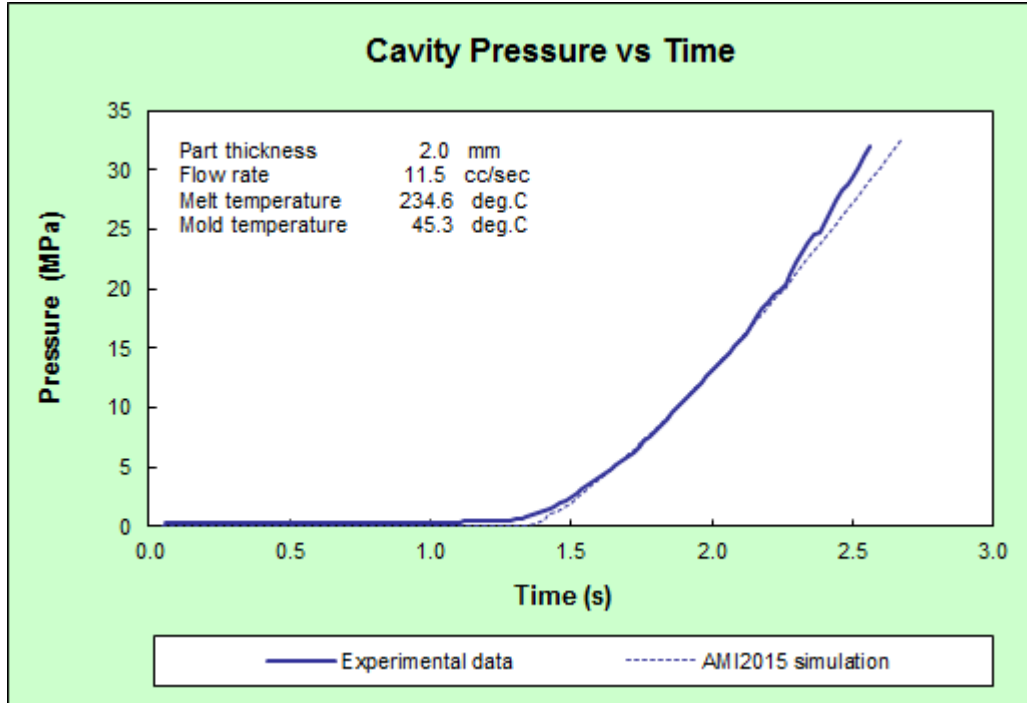
Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0059	7.7	235.8	42.9
Cyc0072	50.1	235.7	50.5





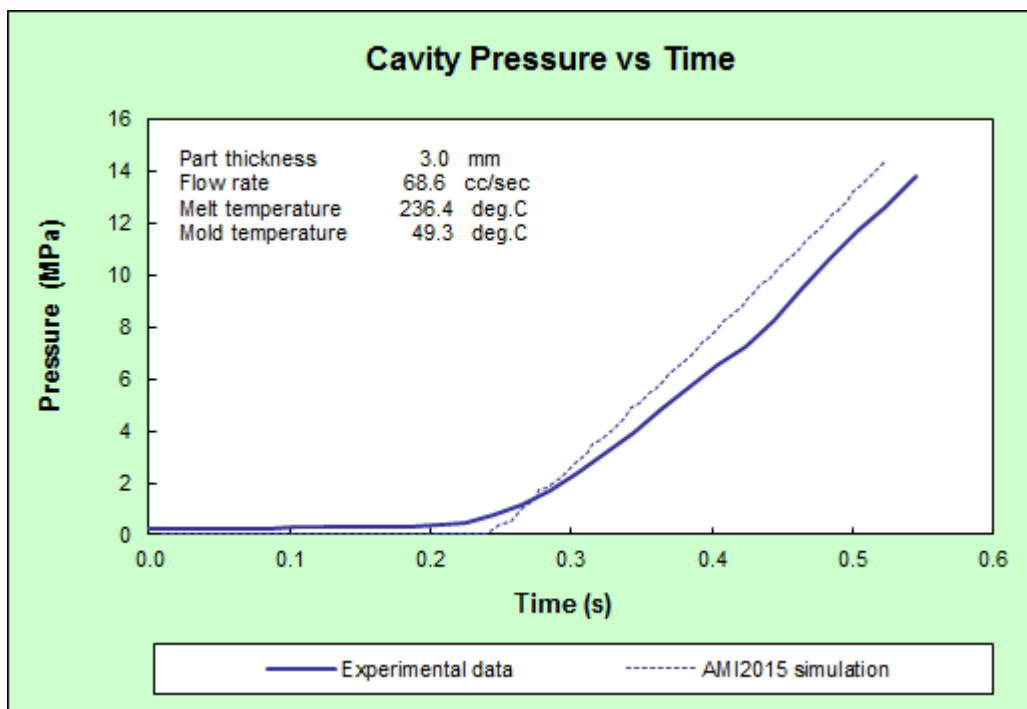
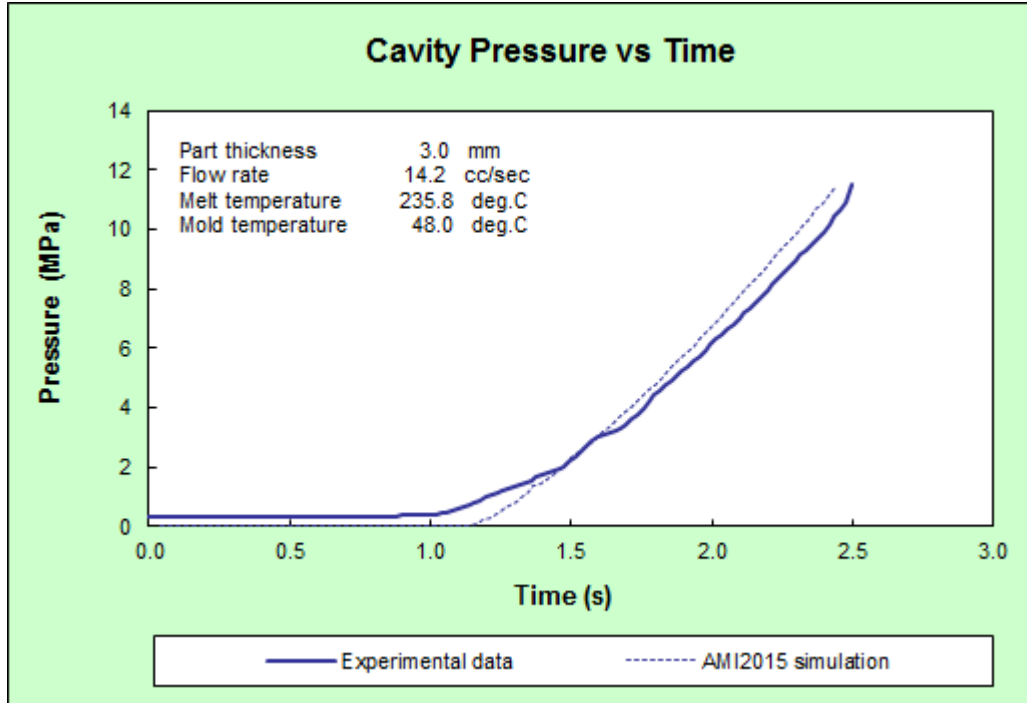
**2mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0109	11.5	234.6	45.3
Cyc0121	63.5	234.6	52



**3mm tag die**

Experiment Number	Flow Rate (cc/sec)	Melt Temperature	Mold Temperature
Cyc0007	14.2	235.8	48
Cyc0019	68.6	236.4	49.3



## Contact details

### United States of America

Autodesk Moldflow Plastics Labs

2353 North Triphammer Road

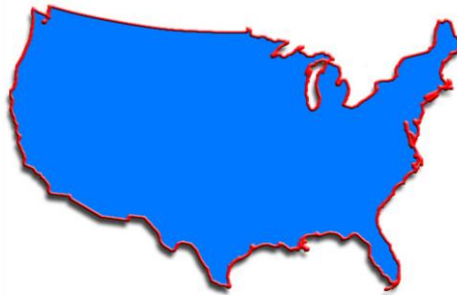
Ithaca, NY 14850

USA

Phone: +1-607- 266-7247

Fax: +1-607- 266-7100

Email: [mplmoldflow@autodesk.com](mailto:mplmoldflow@autodesk.com)



### Australia

Autodesk Moldflow Plastics Labs

259-261 Colchester Road

Kilsyth, Victoria, 3137

Australia

Phone: +61-3-9720-2088

Fax: +61-3-9729-0433

Email: [mplmoldflow@autodesk.com](mailto:mplmoldflow@autodesk.com)



For testing enquiries please email [mplmoldflow@autodesk.com](mailto:mplmoldflow@autodesk.com)

For data fitting and database enquiries please email [datafittingmoldflow@autodesk.com](mailto:datafittingmoldflow@autodesk.com)

Autodesk's corporate website: [www.autodesk.com](http://www.autodesk.com)