Meldin® 7000 Series

Design Guide

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SAINT-GOBAIN
PERFORMANCE PLASTICS

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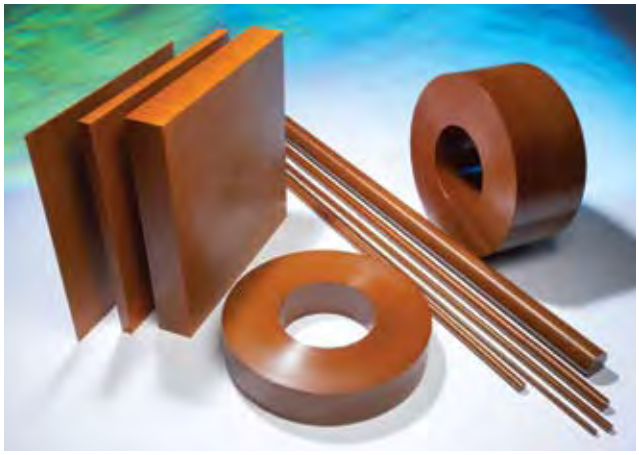
MELDIN® 7000 SERIES DESIGN GUIDE

INTRODUCTION

With more than fifty years of engineered plastics technology and extensive fabrication expertise, Saint-Gobain Polymer Products is recognized the world over as a leader in the high performance polymer components business. The materials and customized components we supply our customers are designed to withstand the harshest environments and perform under the toughest operating conditions. As a result, design engineers trust Saint-Gobain Polymer Products to provide practical, affordable solutions to the most demanding high temperature applications.



The Meldin 7000 series, the flagship of our Meldin product portfolio, is a family of polyimide, direct formable, thermosetting materials that exhibit extremely high dimensional stability and very little degradation of mechanical properties at elevated temperatures over time. In addition, its wear and friction characteristics, chemical resistance, and electrical properties make Meldin 7000 the optimum choice for mechanical components or electrical and thermal insulating applications.

Our state-of-the-art Research & Development testing center and advanced resin production facility enable Saint-Gobain Polymer Products to maintain complete control of the quality and source of the proprietary base polyimide resins used to make Meldin 7000 series. Our "Powder-to-Parts" capability means total process control of resin production, stock shape manufacturing, direct forming, and critical dimensional machining of finished parts to customers' exact specifications.

In most instances, Meldin 7000 series can replace steel or other traditional metals by offering better conformability, lower leakage, lower total part cost, and emergency dry-running capabilities. In fact, the self-lubricating grades of Meldin 7000 do not melt when exposed to high load (P) or high speed (V) applications as compared to other engineered thermoplastic polymers. The P x V limits for Meldin 7000 self-lubricating grades exceed 300,000 psi•ft/min (10.5W/mm^2) in dry environments and surpass 1,000,000 psi•ft/min (35.0 W/mm^2) in liquid or grease lubricated environments. As a result, Meldin 7000 series is used for piston rings and thrust washers in transmissions and pumps for automotive, off-road, agriculture, and aerospace equipment.

Similar to most plastics, Meldin 7000 series products produced by direct forming or hot compression molding techniques exhibit anisotropy behavior. That is to say, differences in property values can be seen whether the material is tested in the direction of force used during fabrication (the mold direction) or perpendicular to the direction of force (the cross-mold direction). For instance, elongation and tensile strength values are higher while thermal expansion data is lower in the cross-mold direction than these same attributes are in the mold direction.

This phenomenon of "directionality" in properties is further pronounced in Meldin 7000 series products containing filler materials (Meldin 7003, 7021, 7022, and 7211). Meldin 7000 series materials are also available as isostatically molded stock shapes. Parts machined from isostatically molded material do not exhibit any "directionality" in performance; therefore, mechanical properties and thermal expansion are uniform in all directions.

Unlike ceramic materials, Meldin 7000 series materials exhibit excellent machinability, which makes them more cost effective for manufacturing finished components. Our production facilities throughout North America, Europe, and Asia allow for local supply of both stock shapes and finish-machined parts, keeping the supply chain as short as possible for our customers.

MELDIN® 7000 SERIES DESIGN GUIDE

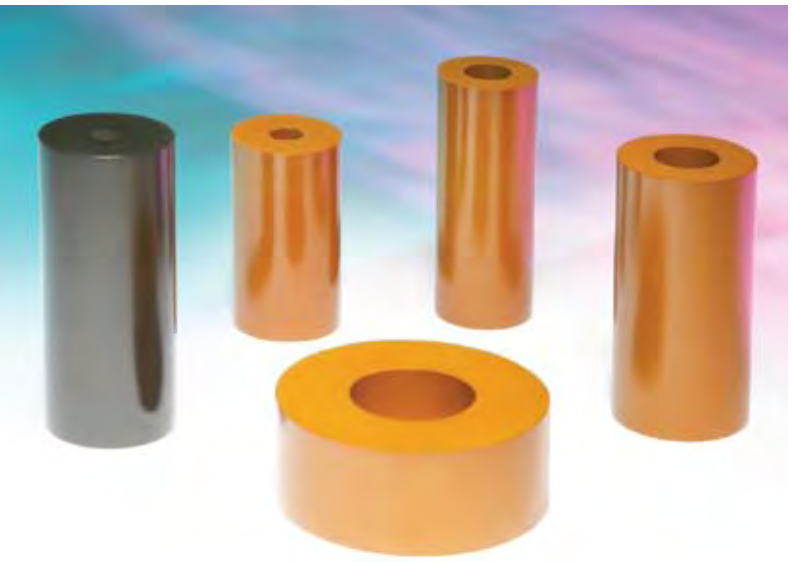
Evident in all the Meldin® 7000 series products is Saint-Gobain Polymer Products' unwavering commitment to quality and service to our customers. Our manufacturing plants have been certified to such worldwide quality standards as:

- AS EN9100
- TS-16949
- ISO-9001
- ISO-14001

Production batches of Meldin 7000 resin are tested to a number of ASTM test methods to ensure the performance characteristics meet the requirements and expectations of the most demanding customers in every industry and market we serve. Finished parts made from Meldin 7000 series are also qualified to such specifications as:

- ASTM D6456-99
- MIL-R-46198
- AMS SAE 3644G
- UL 94

Our devotion to continuous improvement, detailed record keeping, and meticulous inspection processes ensure that we provide the highest quality finished goods – part after part, order after order. As a result of our dedication to quality and tireless efforts to deliver world class service, Saint-Gobain Polymer Products has become the preferred supplier to the world's most respected companies.



Engineers design components and systems that must meet the stringent application requirements of today as well as the performance challenges of tomorrow in such industries as appliances, automotive, aerospace, electronics, instrumentation, and transportation, to name just a few. This design guide is intended to assist design engineers in the selection, testing, and specification of Meldin 7000 series materials to meet these performance challenges.

The *Meldin 7000 Series Design Guide* is the result of countless hours of research, development, and testing by Saint-Gobain's leading research scientists, polymer chemists, and laboratory technicians. The *Meldin 7000 Series Design Guide* contains comprehensive performance data and physical property information that is intended to lend insights as to how Meldin 7000 materials will perform in different environments and conditions. This publication presents averaged property values for direct-formed and machined parts and, therefore, it is strongly suggested not to base specifications on the values contained herein. Though the *Meldin 7000 Series Design Guide* will certainly prove to be invaluable to designers, testing in the actual end-use application is always encouraged and highly recommended.

It is important to note that Saint-Gobain Performance Plastics Corporation does not assume any responsibility or liability for any advice furnished by it, or for the performance or results of any installation or use of Meldin 7000 or of any final product into which Meldin 7000 may be incorporated by the purchaser and/or user. The purchaser and/or user should perform its own tests to determine the suitability and fitness of Meldin 7000 for the particular purpose desired in any given situation.

MECHANICAL PROPERTIES VS. TEMPERATURE

Meldin® 7000 series polyimide materials are highly engineered advanced polymers whose mechanical properties change with changes in temperature (mechanical property values decrease as temperature increases). Furthermore, since Meldin 7000 series products are thermoset materials and do not have a melting or glass transition temperature (T_g) below its continuous use temperature, the tensile strength values decrease in a linear manner as temperature increases. This linear relationship between mechanical properties and temperature helps engineers doing analysis and design work to conduct simulations and calculations that can confidently predict part performance at elevated temperatures.

Figures 1 through 6 show these linear changes in tensile strength, flexural strength, and flexural modulus for machined, isostatically molded shapes and for direct formed parts made from Meldin 7000 series materials.

The Meldin 7000 series materials can operate very well at continuous operating temperatures of 315˚C (600˚F). The Meldin 7000 series materials can also operate intermittently at temperatures up to 482˚C (900˚F).

NOTE: The Meldin 7000 series materials cannot operate at the 482˚C temperature continuously – only for short periods of time. The actual time duration at the 482˚C temperature depends on the heat transfer dynamics of the specific application. The maximum operating temperature of Meldin 7000 series materials is limited by its rate of degradation, not by a softening point where the Meldin 7000 series material would lose its pressure supporting capability.

Figure 1
Meldin 7000 Polyimide Shapes
Typical Ultimate Tensile Strength vs Temperature
ASTM D1708

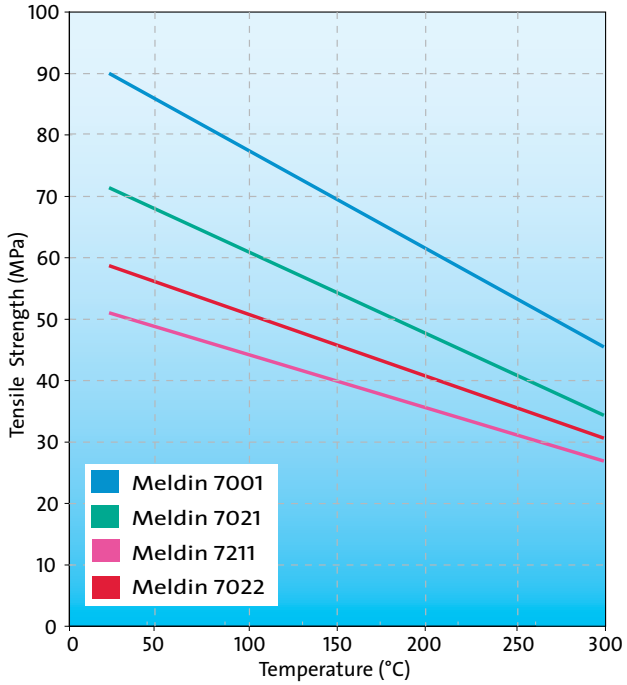


Figure 2
Direct Formed Meldin 7000 Polyimide
Typical Ultimate Tensile Strength vs Temperature
ASTM E8

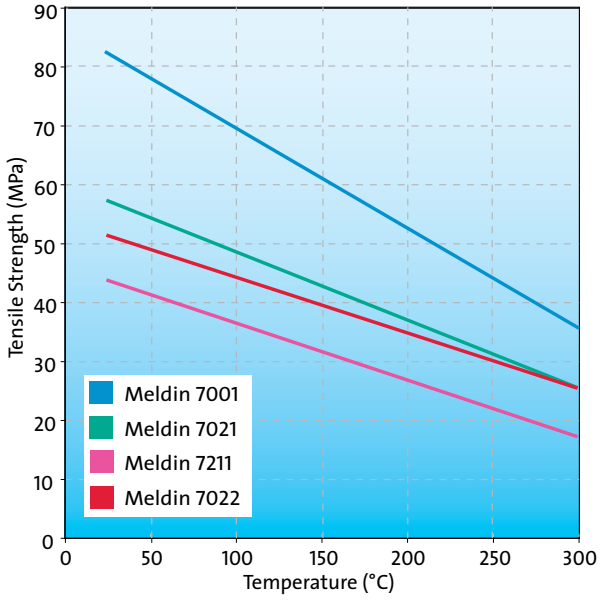


Figure 3
Meldin 7000 Polyimide Shapes
Typical Flexural Modulus vs Temperature
ASTM D790

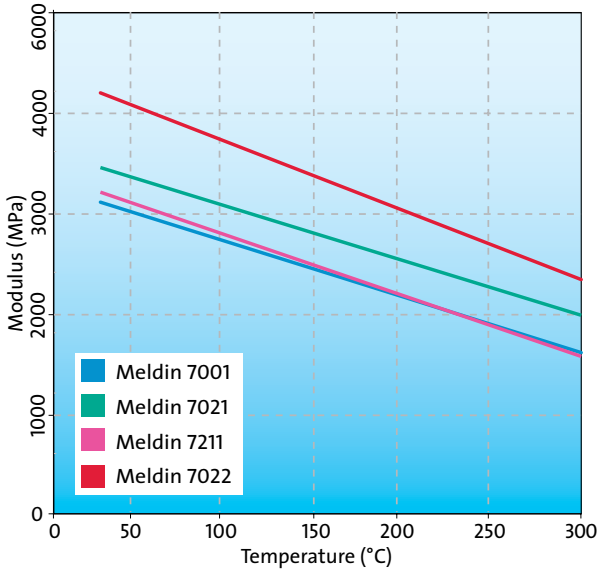


Figure 4
Meldin 7000 Polyimide Shapes
Typical Flexural Strength vs Temperature
ASTM D790

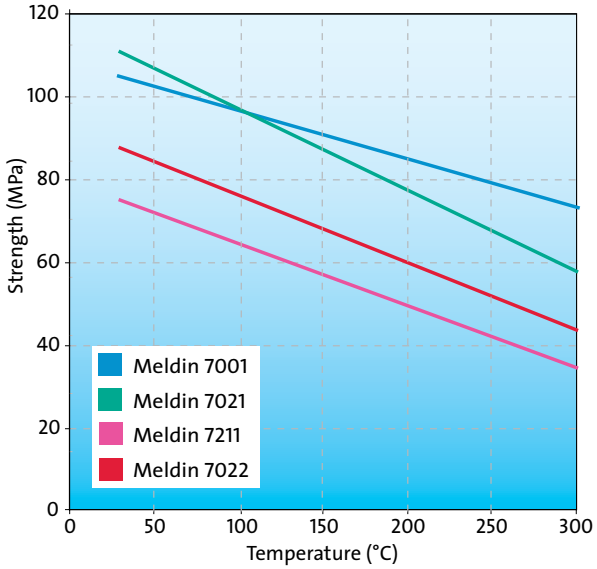


Figure 5
Direct Formed Meldin 7000 Polyimide
Typical Flexural Modulus vs Temperature
ASTM D790

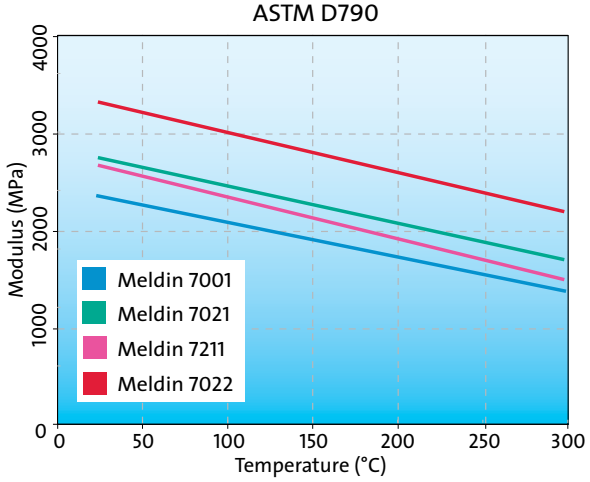
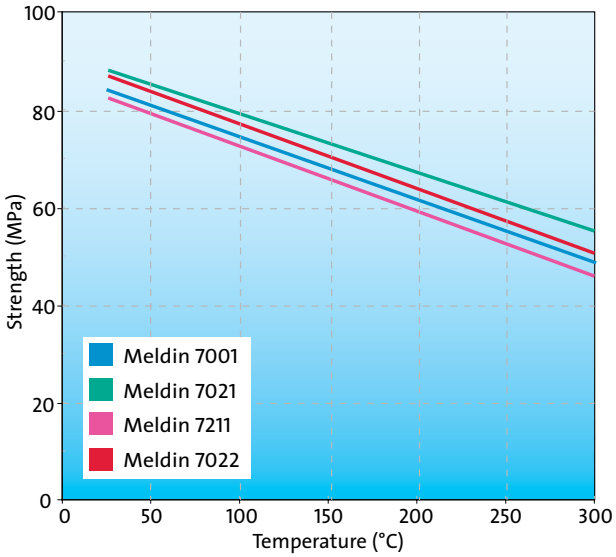


Figure 6
Direct Formed Meldin 7000 Polyimide
Typical Flexural Strength vs Temperature
ASTM D790



FLEXURAL STRENGTH VS. TEMPERATURE

The flexural strength of each Meldin® 7000 series product follows the same gradients over an increasing temperature range. This behavior is quite common since most metals and plastic materials demonstrate a decrease in flexural strength with increasing temperature. It is interesting to note, however, that Meldin 7000 materials exhibit a slightly curved line in property decline whereas many plastic polymers will show a sharp decrease at the T_g. Once more, Meldin 7000 does not have a T_g below its continuous use temperature, which is clearly visible in these and previous graphs.

The offset between the different products can be attributed to the different fillers that are employed in the various Meldin 7000 series products. In other words, the fillers determine the starting point of the property value (the left hand point of the line) and the base polymer determines the behavior due to temperature (the slope of the line).

STRESS-STRAIN INFORMATION

Figures 7 and *8* show the typical stress-strain behavior of the various Meldin 7000 products for ambient (23°C or 73°F) and high temperature (260°C or 500°F) conditions, respectively. As can be seen from these graphs, none of the Meldin 7000 series products have a transition point from elastic to plastic deformation. That is to say, when a tensile force is applied to a Meldin product, the material will essentially deform elastically until it suddenly breaks without having a plastic deformation zone as one would typically expect in parts made of metal or other plastics. One can also note that the filled material products of Meldin 7000 series – Meldin 7003, 7021, 7022, and 7211 – show very similar stress-strain behavior (slope of the lines), but tend to have a lower value for both the stress at break as well as for the strain than the unfilled Meldin 7001 material. In essence, the filled Meldin 7000 series materials tend to be more brittle (i.e., break at a lower total elongation) than the unfilled Meldin 7001 product. Still, the values and product performances reported are typical for a high-quality polyimide material.

Figure 7
Meldin 7000 Polyimide Shapes
Typical Stress-Strain in Tension @ 23°C
ASTM D1708

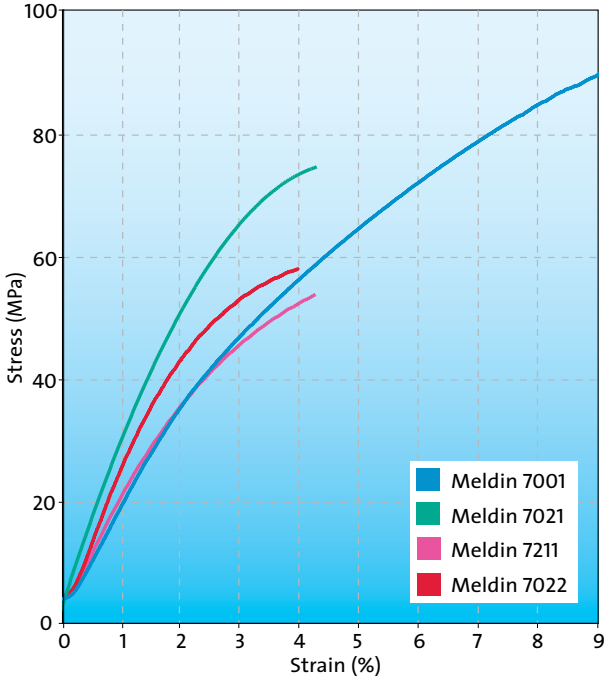
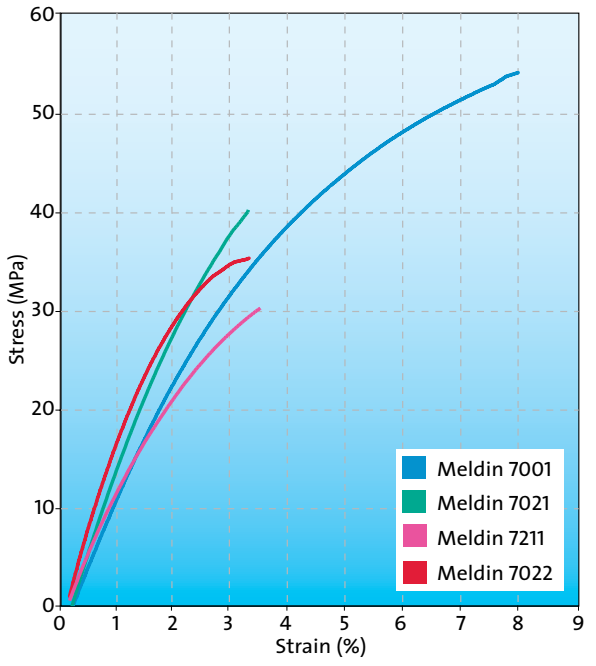


Figure 8
Meldin 7000 Polyimide Shapes
Typical Stress-Strain in Tension @ 260°C
ASTM D1708



DIRECT FORMED STRESS-STRAIN

Figures 9 and *10* show the same stress-strain properties as the previous two figures, except these values are measured perpendicular to the main forming direction. Generally, the observed values for maximum stress are slightly lower in this case since the material properties are known to be weaker in the perpendicular direction. All remarks related to the differences between room temperature and elevated temperature testing stated previously for *Figures 7* and *8* are valid for these two graphs as well.

Figure 9
Direct Formed Meldin 7000 Polyimide
Typical Stress-Strain in Tension @ 23°C
ASTM E8

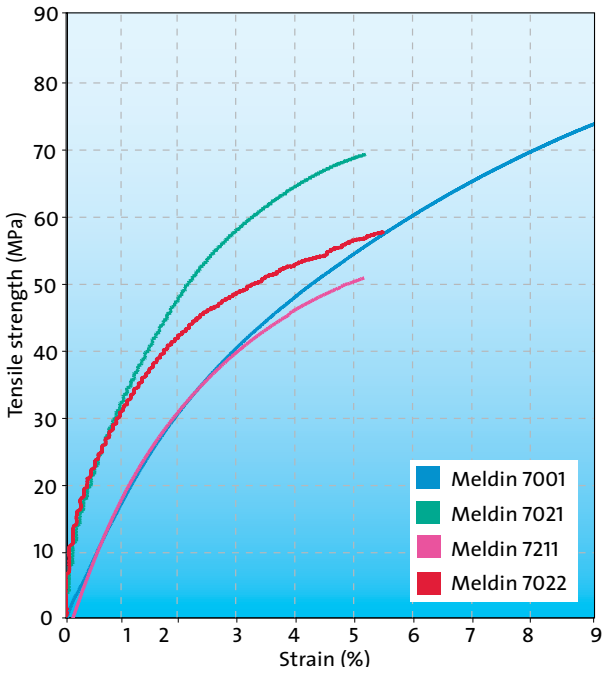
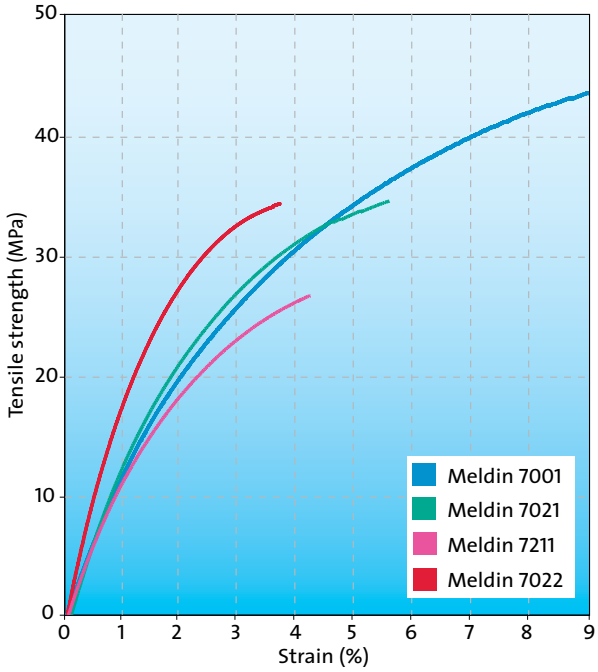


Figure 10
Direct Formed Meldin 7000 Polyimide
Typical Stress-Strain in Tension @ 260°C
ASTM E8



STRESS-STRAIN UNDER COMPRESSION

Figures 11 and *12* illustrate the stress-strain behavior of Meldin® 7000 series materials under compression at 23°C (73°F) and 300°C (572°F), respectively. In the low stress-strain portion of the graphs, the curves are nearly linear, indicating the elastic region of the materials' performance. When staying below the ultimate strength limits of the materials, Meldin 7000 series can withstand high strain conditions without failure. In this regard, polyimides like Meldin 7000 series behave differently than other thermosetting materials and can endure low strain levels without incurring any permanent deformation. As a result, Meldin 7000 series is often the preferred material for use as seals and bearings in mechanical equipment.

Figure 11
Meldin 7000 Polyimide Shapes
Stress-Strain in Compression @ 23°C
ASTM D695

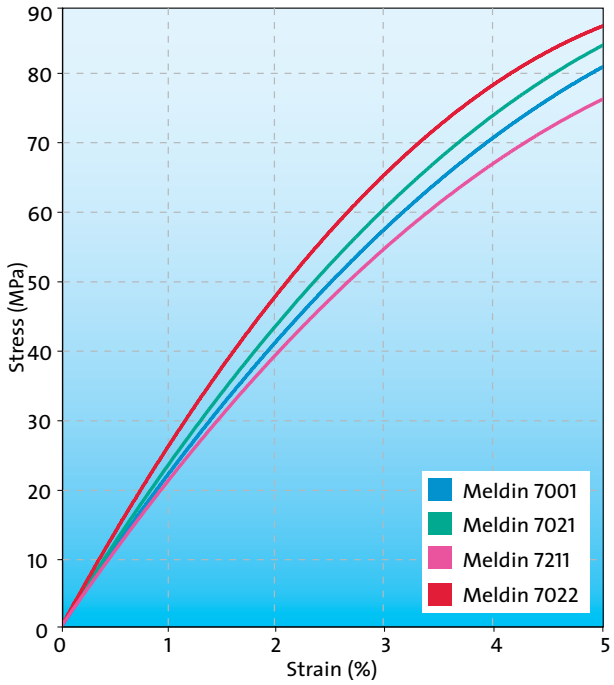
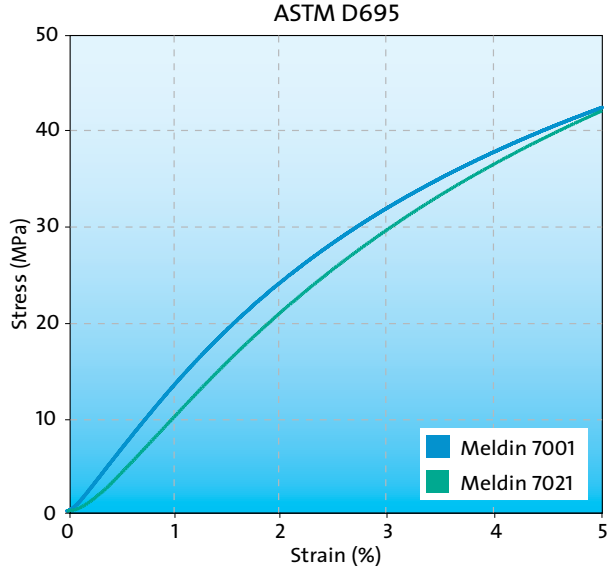


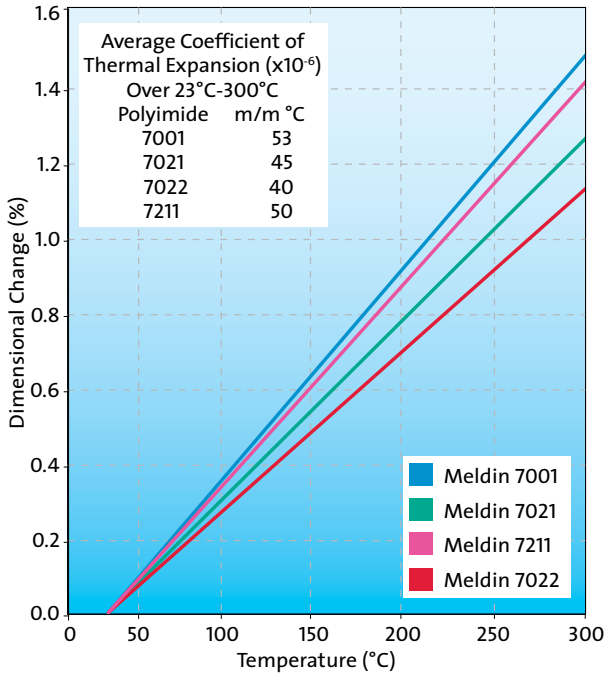
Figure 12
Meldin 7000 Polyimide Shapes
Stress-Strain in Compression @ 300°C
ASTM D695



LINEAR THERMAL EXPANSION

The coefficient of linear thermal expansion over the temperature range of 23°C to 300°C (73°F to 572°F) is shown in *Figure 13*. To calculate the coefficient over any other temperature range using these curves, simply divide the percent dimensional change over the desired range by 100 x the temperature differential in degrees (ΔT).

Figure 13
Meldin 7000 Polyimide Shapes
Linear Thermal Expansion
ASTM D696



TYPICAL PROPERTIES OF MELDIN® 7001 AND 7021

			MELDIN 7001		MELDIN 7021	
		Molding Method Code* →	DF	CM	DF	CM
PROPERTY at @ 73˚F (23˚C)	**TEST METHOD**	**ENGLISH (METRIC)**				
MECHANICAL						
Tensile Strength	ASTM D638	psi (MPa)	10500 (72.4)	12500 (86.2)	9100 (62.7)	9500 (65.5))
Elongation	ASTM D638	%	8.0	8.0	5.5	4.7
Flexural Strength	ASTM D790	psi (MPa)	12800 (88)	15800 (109)	13000 (89.5)	15800 (109)
Flexural Modulus	ASTM D790	psi x 10^5 (GPa)	3.7 (2.5)	4.6 (3.1)	4.5 (3.0)	5.3 (3.6)
Compressive Stress @ 1% Strain	ASTM D695	psi (MPa)	3000 (21)	3800 (26.2)	3400 (23)	4300 (29.7)
Compressive Stress @ 10% Strain	ASTM D695	psi (MPa)	14000 (96.5)	18500 (127.5)	15300 (106)	1800 (124)
Compressive Modulus	ASTM D695	psi x 10^5 (GPa)	2.9 (2.0)	3.8 (2.6)	3.0 (2.1)	4.5 (3.1)
COEFFICIENT OF THERMAL EXPANSION						
73 to 500°F (23 to 260°C)	ASTM E831	in/in/°F (m/m/°C) x 10^{-5}	2.7 (4.9)	2.7 (4.9)	2.0 (3.6)	2.2 (4.0)
-80 to 73°F (-62 to 23°C)	ASTM E831	in/in/°F (m/m/°C) x 10^{-6}	—	—	—	—
Thermal Conductivity	ASTM F433	BTU in/hr ft^2 °F (W/m°C)	2.2 (0.31)	2.4 (0.34)	3.0 (0.43)	5 (0.71)
ELECTRICAL						
Dielectric Strength, Short time 2mm (.08") thick	ASTM D149	V/mil (MV/m)	597 (23.5)	580 (22.9)	—	280 (11)
Dielectric Constant 100 Hz	ASTM D150	—	—	3.18	—	—
Dielectric Constant 10 KHz	ASTM D150	—	—	3.16	—	—
Dielectric Constant 1 MHz	ASTM D150	—	—	3.14	—	—
Surface Resistivity	ASTM D257	Ohm-Sq	—	10^15 - 10^16	—	10^8 - 10^9
OTHER						
Specific Gravity	ASTM D792	—	1.34	1.43	1.42	1.51
Hardness Rockwell E	ASTM D785	—	—	40 - 55	—	25-40
Water Absorption, 24 hours	ASTM D570	%	—	0.23	—	0.19
Water Absorption, 48 hours	ASTM D570	%	—	0.64	—	0.50
Deformation under Load @ 2000 psi	ASTM D-621	%	0.1	0.1	0.14	0.1
Limiting Oxygen Index	ASTM D2863	—	—	100	—	100
High Temperature Dimensional Stability @ 500˚F	INTERNAL	% Change	0.00% Max	—	0.04% Max	—
MECHANICAL PROPERTIES @ 500°F (260°C)						
Tensile Strength	ASTM D638	psi (MPa)	5500 (38)	6250 (43)	4700 (32.4)	5700 (39.3)
Elongation	ASTM D638	%	7.5	5.0	5.2	3.2
Flexural Strength	ASTM D790	psi (MPa)	7000 (48)	9100 (62.7)	7500 (51.7)	8600 (59.3)
Flexural Modulus	ASTM D790	psi x 10^5 (GPa)	2 (1.3)	2.5 (1.7)	2.6 (1.8)	3.5 (2.4)

SPECIFICATION QUALIFICATION					
ASTM D 6456-99 Standard Specification for Finished Parts Made from Polyimide Resin	Satisfies →	Type I D	Type I P	Type II Class 1D	Type II Class 1P
AMS SAE 3644G Polyimide, Molded Rod, Bar and Tube, Plaque, and Formed Parts	Satisfies →	Class 1 Form D	Class 1 Form P	Class 2 Form D	Class 2 Form P
MIL-R-46198 Resin, Polyimide, Hot Pressed or Pressed and Sintered	Satisfies →	Type I D	Type I P	Type II Class 1D	Type II Class 1P

**Molding Method Codes: Direct Formed (DF), Compression Molded (CM)*
NOTE: See page 1-8 for properties of isostatically molded material.

TYPICAL PROPERTIES OF MELDIN® 7022 , 7211 AND 7003

			MELDIN 7022		MELDIN 7211		MELDIN 7003
		Molding Method Code* →	-DF	CM	DF	CM	CM
PROPERTY at @ 73°F (23°C)	**TEST METHOD**	**ENGLISH (METRIC)**					
MECHANICAL							
Tensile Strength	ASTM D638	psi (MPa)	-7200 (49.6)	8000 (55)	8000 (55)	7500 (51.7)	9200 (63.4)
Elongation	ASTM D638	%	-3.0	3.0	5.4	4.0	5.5
Flexural Strength	ASTM D790	psi (MPa)	-10500 (72.4)	13000 (89.6)	11000 (75.8)	11800 (81.4)	13000 (89.6)
Flexural Modulus	ASTM D790	psi x 10^5 (GPa)	-6.7 (4.5)	7.7 (5.2)	4.0 (2.7)	5.0 (3.4)	4.6 (3.1)
Compressive Stress @ 1% Strain	ASTM D695	psi (MPa)	-3300 (22.8)	4700 (32.4)	2300 (15.9)	3500 (24)	3700 (25.5)
Compressive Stress @ 10% Strain	ASTM D695	psi (MPa)	-14000 (96.5)	15500 (107)	11200 (77.2)	14950 (103)	17000 (117)
Compressive Modulus	ASTM D695	psi x 10^5 (GPa)	-2.9 (2.0)	4.8 (3.3)	2.5 (1.7)	3.5 (2.4)	3.6 (2.5)
COEFFICIENT OF THERMAL EXPANSION							
73 to 500°F (23 to 260°C)	ASTM E831	in/in/°F (m/m/°C) x 10^{-5}	-1.1 (2.0)	1.4 (2.5)	2.4 (4.3)	2.4 (4.3)	—
-80 to 73°F (-62 to 23°C)	ASTM E831	in/in/°F (m/m/°C) x 10^{-6}	-—	—	—	—	—
Thermal Conductivity	ASTM F433	BTU in/hr ft^2 °F (W/m°C)	-	—	—	5.2 (0.74)	—
ELECTRICAL							
Dielectric Strength, Short time 2mm (.08") thick	ASTM D149	V/mil (MV/m)	-	—	—	—	—
Dielectric Constant 100 Hz	ASTM D150	—	-	—	—	—	—
Dielectric Constant 10 KHz	ASTM D150	—	-	—	—	—	—
Dielectric Constant 1 MHz	ASTM D150	—	-	—	—	—	—
Surface Resistivity	ASTM D257	Ohm-Sq	-	—	—	—	—
OTHER							
Specific Gravity	ASTM D792	—	-	1.65	1.45	1.53	1.61
Hardness Rockwell E	ASTM D785	—	—	5-20	—	1 - 15	—
Water Absorption, 24 hours	ASTM D570	%	—	0.25	—	0.23	—
Water Absorption, 48 hours	ASTM D570	%	—	0.48	—	0.46	—
Deformation under Load @ 2000 psi	ASTM D-621	%	0.15	—	0.2	—	—
Limiting Oxygen Index	ASTM D2863	—	—	—	—	—	—
High Temperature Dimensional Stability @ 500°F	INTERNAL	% Change	0.002% Max	—	0.002% Max	—	—
MECHANICAL PROPERTIES @ 500°F (260°C)							
Tensile Strength	ASTM D638	psi (MPa)	4000 (27.6)	4500 (31)	4300 (29.7)	4300 (29.7)	—
Elongation	ASTM D638	%	3.0	2.4	5.1	2.8	—
Flexural Strength	ASTM D790	psi (MPa)	6000 (41.4)	7000 (48.3)	6000 (41.4)	6000 (41.4)	—
Flexural Modulus	ASTM D790	psi x 10^5 (GPa)	3.8 (2.6)	5.2 (3.6)	2.7 (1.9)	3.0 (2.1)	—
SPECIFICATION QUALIFICATION							
ASTM D 6456-99 Standard Specification for Finished Parts Made from Polyimide Resin		Satisfies →	Type II Class 2D	Type II Class 2P	Type II Class 3D	Type II Class 3P	Type III
AMS SAE 3644G Polyimide, Molded Rod, Bar and Tube, Plaque, and Formed Parts		Satisfies →	Class 3 Form D	Class 3 Form P	Class 4 Form D	Class 4 Form P	Class 5 Form P
MIL-R-46198 Resin, Polyimide, Hot Pressed or Pressed and Sintered		Satisfies →	Type II Class 2D	Type II Class 2P	Type II Class 3D	Type II Class 3P	Type III

**Molding Method Codes: Direct Formed (DF), Compression Molded (CM)*
NOTE: See page 1-8 for properties of isostatically molded material.

TYPICAL PROPERTIES OF ISOSTATICALLY MOLDED MELDIN® 7000

PROPERTY	ASTM Method	Units	Meldin 7001	Meldin 7003	Meldin 7021	Meldin 7022	Meldin 7211
MECHANICAL							
Tensile Strength	D638	psi (MPa)	12,500 (86)	9,000 (62.1)	9,500 (65.5)	7,500 (51.7)	6,800 (46.9)
Elongation	D638	%	7.5	4.5	4.5	3.2	3.5
Tensile Strength @ 500°F (260°C)	D638	psi (MPa)	5,400 (37)	—	5,500 (38)	—	—
Elongation @ 500°F (260°C)	D638	%	4.5	—	4.3	—	—
Flexural Strength	D790	psi (MPa)	15,200 (105)	13,600 (93.7)	15,600 (108)	13,100 (90.3)	11,300 (77.9)
Flexural Modulus	D790	psi x 10^5 (GPa)	4.6 (3.2)	5.2 (3.6)	5.7 (3.9)	6.4 (4.4)	4.9 (3.4)
Compressive Stress @ 1% Strain	D695	psi (MPa)	3,300 (22.7)	3,600 (24.8)	3,800 (26.2)	4,000 (27.6)	3,300 (22.7)
Compressive Stress @ 10% Strain	D695	psi (MPa)	18,000 (124)	18,000 (124.1)	19,300 (133)	16,000 (110.3)	15,500 (106.9)
Compressive Stress @ 0.1% Offset	D695	psi (MPa)	—	6,000 (41.4)	—	6,000 (41.4)	5,300 (36.5)
Compressive Modulus	D695	psi x 10^5 (GPa)	2.9 (2.0)	3.63 (2.5)	3.26 (2.3)	4.09 (2.8)	3.34 (2.3)
THERMAL EXPANSION							
75 to 500°F (24 to 260°C)	E-831	in/in/°F x 10^{-5} (m/m/°C)	2.7 (5.0)	2.87 (5.16)	2.5 (4.5)	2.23 (4.0)	2.8 (5.0)
ELECTRICAL							
Dielectric Strength	D149	V/mil (MV/m)	450 (18)	—	104 (4.0)	—	—
OTHER							
Specific Gravity	D792	—	1.43	1.61	1.51	1.67	1.55
Hardness Rockwell E	D785	—	64	46	50	24	23
Water Absorption, 24 Hours	D570	%	0.23	0.24	0.2	0.17	0.17
SPECIFICATION QUALIFICATION							
ASTM D 6456-99 Standard Specification for Finished Parts Made from Polyimide Resin		Satisfies →	Type 1M	Type III Class M	Type II Class 1M	Type II Class 2M	Type II Class 3M
AMS SAE 3644G Polyimide, Molded Rod, Bar and Tube, Plaque, and Formed Parts		Satisfies →	Class 1 Form M	Class 5 Form M	Class 2 Form M	Class 3 Form M	Class 4 Form M
MIL-R-46198 Resin, Polyimide, Hot Pressed or Pressed and Sintered		Satisfies →	Type 1M	Type III Class M	Type II Class 1M	Type II Class 2M	Type II Class 3M

NOTE: This data falls within the normal range of properties but should not be used to establish specification limits nor used alone as the basis of design. Saint-Gobain Performance Plastics assumes no obligation or liability for any advice furnished by it or for results obtained with respect to the products.

CHEMICAL RESISTANCE AND FLAMMABILITY RATING

CHEMICAL NAME	Meldin 7001	Meldin 7021	Meldin 7022	Meldin 7211
Acetic Acid (15%)	C	C	C	C
M-Cresol	B*	B*	B*	B*
o-Dichlorobenzene	A	A	A	A
Diethyl Ether	A	A	A	A
Ethanol	A	A	A	A
Hydraulic Fluid, Polyphosphate Ester	A	A	A	A
Hydrochloric Acid (38% @RT)	B	B	B	B
Hydrochloric Acid (5%, 100C)	C	C	C	C
JP-4 Jet Fuel	A	A	A	A
Jet Engine Oils (MIL L78086, T2)	A	A	A	A
Mineral Oil	A	A	A	A
Nitric Acid (70%)	B-C	B-C	B-C	B-C
Nitrobenzene	B*	B*	B*	B*
Nitrogen Tetroxide	B	B	B	B
Perchloroethylene	A	A	A	A
Silicone Fluid	A	A	A	A
Sodium Hydroxide (5%)	C	C	C	C
Tricresyl Phosphate	B	B	B	B
Toluene	A	A	A	A

A - Highly Resistant
B - Moderately Resistant
C - Reduced Resistance

UL 94 FLAMMABILITY RATING	Meldin 7001	Meldin 7021	Meldin 7022	Meldin 7211
	V-0, 5VA Tested and Passed	V-0, 5VA Tested and Passed	V-0, 5VA Tested and Passed	V-0, 5VA Tested and Passed
	V-0, 5VA UL Listed			

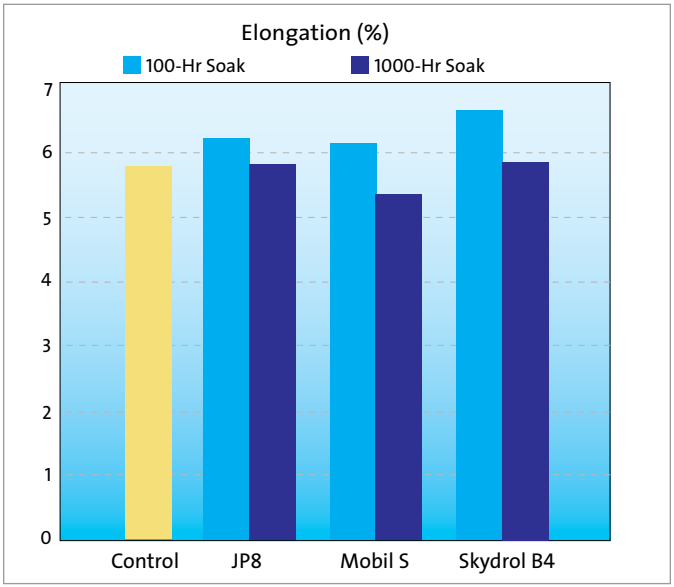
MELDIN® 7021 AEROSPACE FLUID TESTS

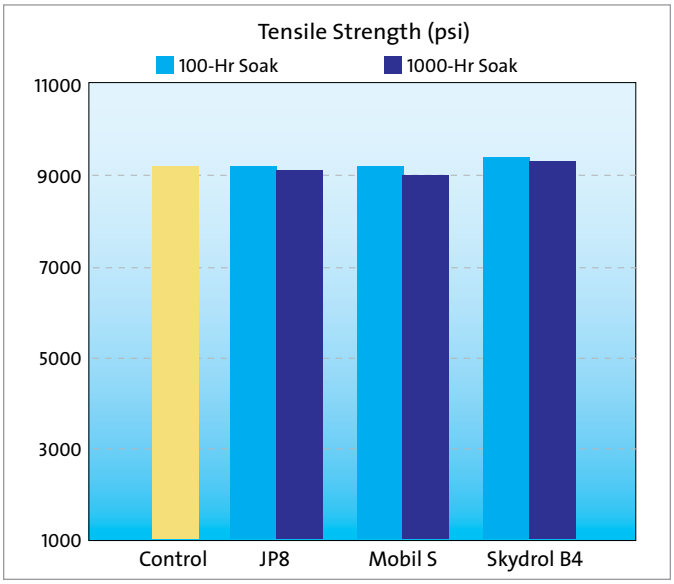
Test Conditions

Measure the tensile strength and % elongation of a control sample and then immerse tensile bars in each fluid for 100 hours and 1000 hours. After each time period, the tensile bars were dried and tested to determine if there were any effects from the immersion in common aerospace fluids.

Conclusion

As seen in the following graphs, Meldin 7021 shows no ill effects after long-term immersion in common aerospace fluids.





APPENDIX

MELDIN® 7000 POLYIMIDE MATERIAL SELECTION GUIDE

Grade Name	Meldin 7001	Meldin 7021	Meldin 7022	Meldin 7211	Meldin 7003
Max Use Temp.	315°C (600°F)*	315°C (600°F)*	315°C (600°F)*	315°C (600°F)*	315°C (600°F)*
T_g (Glass Transition Temp.)	Has no T_g**	Has no T_g**	Has no T_g**	Has no T_g**	Has no T_g**
Fillers	Unfilled Base Resin	15% Graphite	40% Graphite	15% Graphite, 10% PTFE	15% Molybdenum Disulfide
Mfg. Method: Direct Forming	x	x	x	x	x
Mfg. Method: Hot Compresson Molding	x	x	x	x	x
Mfg. Method: Isostatic Molding	x	x	x	x	x
Characteristics	High electrical and thermal insulation	Wear resistant	High dimensional stability	Low friction, high speed capability	Self-lubricating in dry/vacuum conditions
Applications	Insulators, structural components, semiconductor equipment	Bearings, thrust washers, sealing rings	Bearings, thrust washers, glass handling	Bearings, thrust washers, wear guides	Bearings, thrust washers, sliding elements

** Intermittent exposure to 482°C (900°F)*
*** Meldin 7000 has no softening point. TGA tests show it burns off less than 5% by weight up to temperatures of 600°C (1112°F).*

MELDIN 7000 MACHINING GUIDELINES

Tooling

The Meldin 7000 family of materials is easily machined due to the mechanical strength, stiffness, and dimensional stability of the material. The relative lower grades of carbide, such as C-2, are probably the best tools to employ. The tool life is exceptional. A feed rate between .03mm (.001") and .10mm (.004") per revolution will result in an acceptable finish. A feed rate of .03mm (.001") per revolution will result in a maximum 0.8 µm R_a (32 µinch) finish. Chip-breaker designed tools work well.

Holding the material is crucial in machining a satisfactory product. Using a six-jaw chuck assures an even distribution of force exerted by the jaws. Collets are the best method of holding the piece, because they encase over 90% of the piece part periphery.

Turning and Boring

When rough turning and boring it is advisable to use a feed rate of .3mm – .4mm/rev (.010" – .015"/rev). When finish turning and boring it is advisable to use a feed rate of .03mm – .10mm/rev (.001" – .004"/rev).

Milling

Carbide end mills are appropriate in milling Meldin 7000 materials and result in little or no chipping. Fly cutting is also acceptable and produces very good finishes on the piece being machined.

Drilling

Standard HSS drills are acceptable. Solid carbide drills will have longer life.

Measuring

Meldin 7000 is a plastic and care should be taken when checking for part dimensions. For example: If the person checking the piece were to use standard measuring techniques, clamping down on the piece, the force of the instrument may distort the piece ever so slightly. It is therefore recommended to use the "go/no-go" method:

Set the micrometer at the high end of the tolerance and pass the piece through the jaws of the micrometer with no drag; the piece is acceptable. Set the micrometer at the low end of the tolerance and attempt to pass the piece through the jaws. Any resistance felt from trying to pass the piece through the jaws means the piece is above the low end of the tolerance and also acceptable.

Pins should not be forced through a bore. The pin should be allowed to fall through the I.D. bore by its own free weight.

BASIC SHAPES

Meldin® 7000 series materials are offered in a variety of basic shapes including blocks, disks, rods, and tubes. These basic shapes afford customers the shortest possible lead times, optimum material utilization, and the ultimate in design flexibility.

**Meldin 7000 Basic Shapes*
Direct Formed Parts
(Sizes are for reference only)**

Part Type	L (in)	W (in)	H (in)	L (mm)	W (mm)	H (mm)
Blocks	1.410	0.460	0.950	35.8	11.7	24.1
	1.533	0.784	0.152	38.9	19.9	3.9
	2.172	0.239	0.152	55.2	6.1	3.9
	3.611	0.492	0.400	91.7	12.5	10.2
	4.165	0.210	0.810	105.8	5.3	20.6

Part Type	OD (in)	ID (in)	H (in)	OD (mm)	ID (mm)	H (mm)
Disks	0.656	N/A	0.250	16.7	N/A	6.4
	1.351	N/A	0.250	34.3	N/A	6.4

Part Type	OD (in)	ID (in)	L (in)	OD (mm)	ID (mm)	L (mm)
Tubes	0.441	0.162	0.910	11.2	4.1	23.1
	0.565	0.300	0.600	14.4	7.6	15.2
	0.750	0.164	1.560	19.1	4.2	39.6
	0.750	0.164	1.620	19.1	4.2	41.1
	1.290	0.434	0.990	32.8	11.0	25.1
	1.290	0.434	0.750	32.8	11.0	19.1
	1.291	0.435	0.562	32.8	11.0	14.3
	1.291	0.435	0.787	32.8	11.0	20.0
	1.293	0.435	0.911	32.8	11.0	23.1
	1.500	0.700	1.000	38.1	17.8	25.4
	1.876	0.985	0.890	47.7	25.0	22.6
	2.087	1.496	0.750	53.0	38.0	19.1
	2.559	1.811	0.500	65.0	46.0	12.7
	2.559	1.811	0.750	65.0	46.0	19.1
	2.559	1.811	1.000	65.0	46.0	25.4
	2.559	1.811	1.160	65.0	46.0	29.5

**Blocks, disks, and tubes in other dimensions are available upon request. Consult a Saint-Gobain Polymer Products representative for assistance.*

**Meldin 7000 Basic Shapes*
Molded Rods
(Sizes are for reference only)**

Part Type	Diameter (in)	Length (in)	Diameter (mm)	Length (mm)
Isostatic Molded Rods	0.250	38	6.4	965
	0.375	38	9.5	965
	0.050	38	1.3	965
	0.625	38	15.9	965
	0.750	38	19.1	965
	0.875	38	22.2	965
	1.000	38	25.4	965
	1.250	38	31.8	965
	1.500	38	38.1	965
	1.750	38	44.5	965
	2.000	38	50.8	965
	3.250	38	82.6	965

Part Type	Diameter (in)	Length (in)	Diameter (mm)	Length (mm)
Compression Molded Rods	0.250	12	6.4	305
	0.375	12	9.5	305
	0.050	12	1.3	305
	0.625	12	15.9	305
	0.750	12	19.1	305
	0.875	12	22.2	305
	1.000	12	25.4	305
	1.250	12	31.8	305
	1.500	12	38.1	305
	1.750	12	44.5	305
	2.000	12	50.8	305

**Blocks, disks, and tubes in other dimensions are available upon request. Consult a Saint-Gobain Polymer Products representative for assistance.*

		INJECTION MOLDING	AGRICULTURAL PLASTICS	NORGLIDE® BEARINGS	NORSLIDE®	OMNIFLEX™	OMNILIP™	OMNISEAL®	OMNISHIELD™	OMNISPRING™	MELDIN®	RULON®	RAM EXTRUSION	MACHINED & MOLDED COMPONENTS
NORTH AMERICA														
* Saint-Gobain Performance Plastics Corporation Wayne, New Jersey • USA	Phone: (1) 973-696-4700 Fax: (1) 973-696-4056		•	•										
* Saint-Gobain Performance Plastics Corporation Bristol, Rhode Island • USA	Phone: (1) 401-253-2000 Fax: (1) 401-253-1755	•						•			•	•		•
* Saint-Gobain Performance Plastics Corporation Garden Grove, California • USA	Phone: (1) 714-630-5818 Fax: (1) 714-688-2614				•	•	•		•	•			•	•
* Saint-Gobain Performance Plastics Corporation Saltillo • Mexico	Phone: (52) 844 866 1200 Fax: (52) 844 180 82 13	•									•	•	•	•
EUROPE														
* Saint-Gobain Performance Plastics Pampus GmbH Willich • Germany	Phone: (49) 2154 600 Fax: (49) 2154 60310		•	•								•		•
* Saint-Gobain Performance Plastics N.V. Kontich • Belgium	Phone: (32) 34 58 28 28 Fax: (32) 34 58 26 69				•		•	•	•	•	•	•		•
Saint-Gobain Performance Plastics Agrate Brianza (Mi) • Italy	Phone: (39) 03 96 50 070 Fax: (39) 03 96 52 736		•	•	•		•	•			•	•	•	
* Saint-Gobain Performance Plastics Kolo • Poland	Phone: (48) 063 2617 100 Fax: (48) 063 2720 401						•							
Saint-Gobain Performance Plastics Espana, S.A. Barcelona • Spain	Phone: (34) 93 682 8138 Fax: (34) 93 682 8143		•	•										
* Saint-Gobain Performance Plastics Espana, S.A. Logrono • Spain	Phone: (34) 94 14 86 035 Fax: (34) 94 14 37 095	•						•			•	•		•
SOUTH AMERICA														
* Saint-Gobain Ceramicas Industrias Ltda. Vinhedo-SP • Brazil	Phone: (55) 19 3876 8153 Fax: (55) 19 3876 8077	•	•	•	•		•	•			•	•		
ASIA														
* Saint-Gobain KK-Performance Plastics Tokyo • Japan	Phone: (81) 33 26 30 285 Fax: (81) 33 26 30 286		•	•	•		•	•			•	•	•	•
* Saint-Gobain Performance Plastics Korea Co., Ltd. Seoul • South Korea	Phone: (82) 25 08 82 00 Fax: (82) 25 54 15 50		•	•	•		•	•			•	•		•
* Saint-Gobain Performance Plastics Shanghai Co., Ltd. Shanghai • China	Phone: (86) 21 54 72 15 68 Fax: (86) 21 54 72 60 35	•	•	•	•		•	•	•	•	•	•	•	•
* Saint-Gobain Advanced Materials (Taiwan) Co., Ltd. Taipei • Taiwan	Phone: (886) 22 50 34 201 Fax: (886) 22 50 34 202		•	•	•		•	•			•	•		•
* Grindwell Norton Ltd. Bangalore • India	Phone: (91) 80 847 2900 Fax: (91) 80 847 2905		•	•	•		•	•			•	•		
Saint-Gobain Performance Plastics Johor • Malaysia	Phone: (60) 7 2686022 Fax: (60) 7 2686027		•	•	•		•	•						
* Saint-Gobain Advanced Materials (M) Sdn.Bhd Selangor Darul Ehsan • Malaysia	Phone: (60) 37 36 40 82/81 Fax: (60) 37 36 40 99		•	•	•		•	•			•	•		

** Manufacturing Facilities*

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SAINT-GOBAIN
PERFORMANCE PLASTICS

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