

SAINT-GOBAIN SEALS



**Meldin®**  
Tolerance Control

# Meldin®

HIGH-PERFORMANCE THERMOSET POLYIMIDE MATERIALS



Critical parts  
making THE difference



PRECISE  
FIT

LIFETIME  
CONFIDENCE



SAINT-GOBAIN

# Principal Features of Meldin® Materials

## Dimensional Stability at High Temperature

Meldin® series materials exhibit extremely high dimensional stability at elevated temperatures. Testing has shown Meldin® materials have less than 0.04% variation from its original dimensions after cycling from 73°F (22.77°C) to 500°F (260°C) over a 2-day period.

The material is able to withstand thermal shocks very well, adding to the dimensional stability of the material. One particular grade – Meldin® 7022 – exhibits an extremely low coefficient of thermal expansion, resulting in a thermal expansion behavior similar to aluminum.

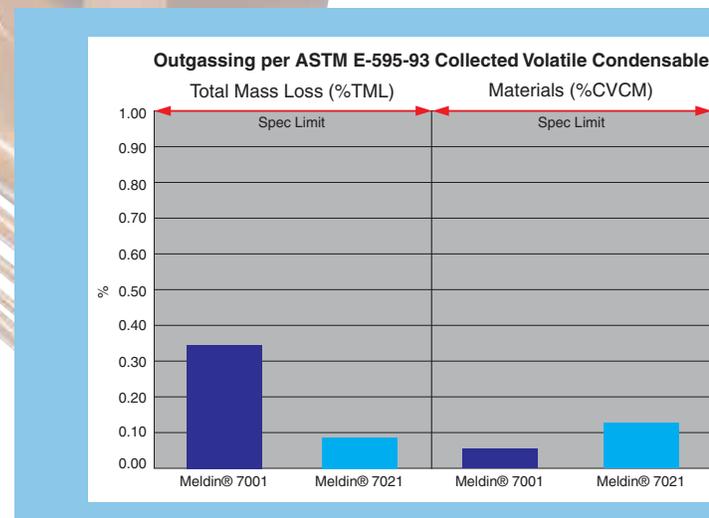
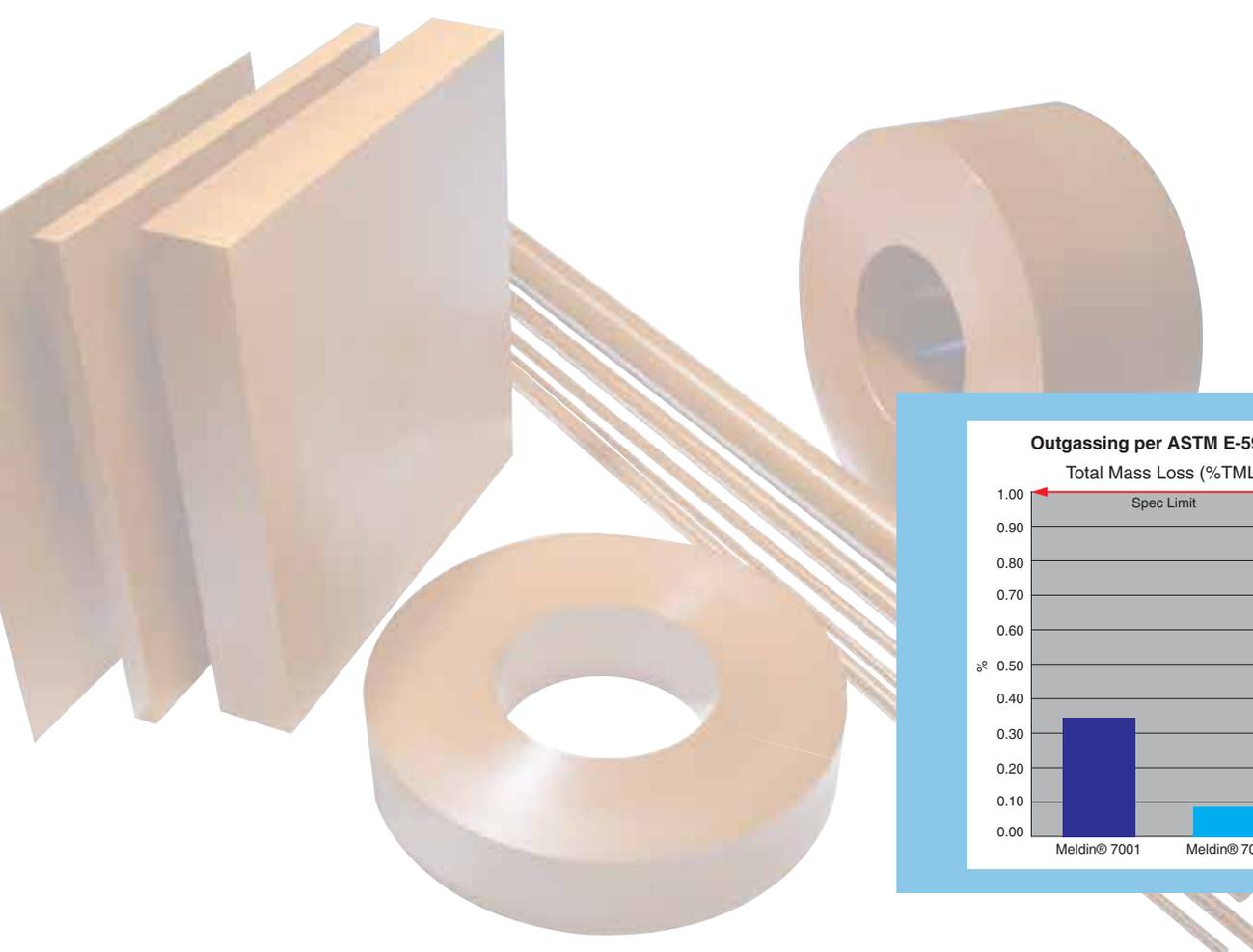
## Total Process Control... Powder-to-Parts

Our expanded resin production facility and our R&D testing labs allow Saint-Gobain Performance Plastics to maintain control of the quality and source of the base polyimide resin. Our "Powder-to-Parts" capability means total process control of resin polymerization and production, stock shape manufacturing, direct forming, and critical dimensional machining of your finished parts.

Meldin® series materials have excellent processability. Unlike ceramic materials, Meldin® series materials exhibit very good machinability, which makes them much more cost effective for manufacturing finished components. Our production sites located all over the world allow for a local supply of stock shape and finish-machined parts, keeping the supply chain for our customers as short as possible.

## Longer Life at Higher Loads and Speeds

The self-lubricating grades of Meldin® do not melt when exposed to high load (P), or high speed (V) applications, as compared to more traditional PTFE or thermoplastic polymers. P x V limits for Meldin® self-lubricating grades exceed 300,000 psi•ft/min (10.5 W/mm<sup>2</sup>) in dry environments and past 1,000,000 psi•ft/min (35.0 W/mm<sup>2</sup>) in liquid or grease lubricated environments.



# Meldin® Thermoset Polyimide Materials



## Meldin® 7001, Unfilled Grade

A thermosetting polyimide, Meldin® 7001 is our unfilled base resin. This grade offers the maximum mechanical properties and high chemical resistance. The Meldin® 7001 grade is ideal for electrical and thermal insulating applications. More ductile than ceramics and lighter weight than metals, Meldin® 7001 is a popular choice for structural parts in aerospace and other applications where metal replacement is desirable. The purity of Meldin® 7001 in combination with the above-mentioned properties make this material the ideal choice for semiconductor applications, successfully replacing aluminum, ceramic and other high-performance plastics. Since Meldin® 7001 is a thermosetting polyimide, it has no glass transition temperature and no melting temperature. This is an essential property for high-temperature applications.

## Meldin® 7003

Meldin® 7003 includes 15% molybdenum disulfide self-lubricating filler for wear applications that operate in a vacuum or in very dry conditions.

## Meldin® 7211, Lowest Friction Grade

Meldin® 7211 has 10% PTFE and 15% graphite filler, which provides our lowest coefficient of friction grade.

## Meldin® 7021, Self-Lubricating Grade

Our self-lubricating grade, Meldin® 7021, has 15% by weight graphite fillers, encapsulated by the base polyimide resin. With its low coefficient of friction and high heat resistance (up to 900°F [482°C]), Meldin® 7021 provides our customers the best all-around choice for high temperature bearings, seals, thrust washers, and other low-wear applications.

## Meldin® 7022

With 40% graphite filler, the Meldin® 7022 grade offers additional dimensional stability at elevated temperatures and the lowest coefficient of thermal expansion of any Meldin® series grade.

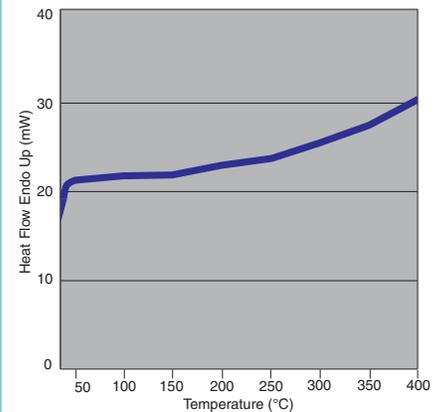
### Product availability:

- Basic shapes
- Finished parts

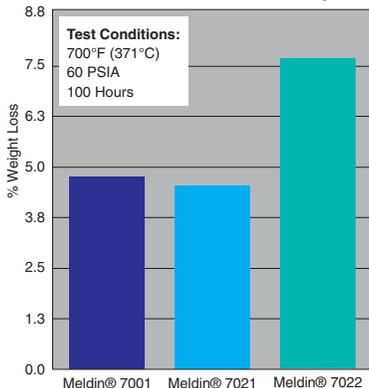
### Manufacturing processes:

- Compression Molding
- Injection Molding
- Direct forming
- Machined parts

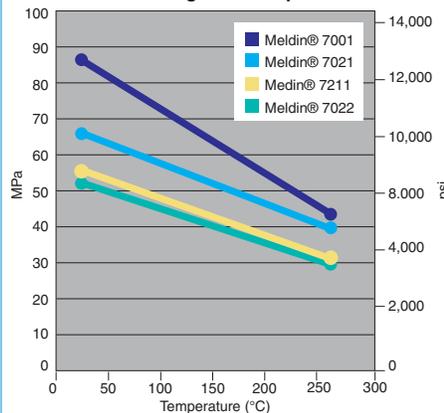
Differential Scanning Calorimetry (DSC)  
Meldin® 7000 Series



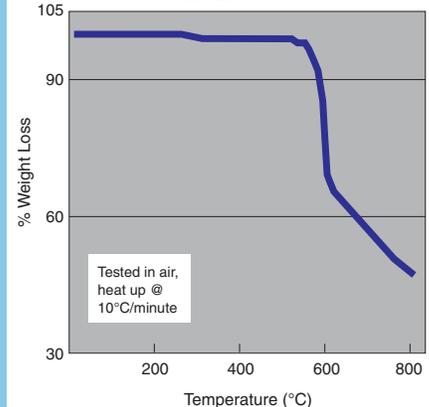
Thermal Oxidative Stability



Hot Compression Molded Tensile Strength vs. Temperature



Thermogravimetric Analysis (TGA)  
Meldin® 7001



# Typical Properties of Meldin® Materials

## MELDIN® 7001

PROPERTY at @ 73°F (23°C)	TEST METHOD	Molding Method Code* →	DF	CM
		ENGLISH (METRIC)		
<b>MECHANICAL</b>				
Tensile Strength	ASTM D638	psi (MPa)	10500 (72.4)	12500 (86.2)
Elongation	ASTM D638	%	8.0	8.0
Flexural Strength	ASTM D790	psi (MPa)	12800 (88)	15800 (109)
Flexural Modulus	ASTM D790	psi x 10 <sup>5</sup> (GPa)	3.7 (2.5)	4.6 (3.1)
Compressive Stress @ 1% Strain	ASTM D695	psi (MPa)	3000 (21)	3800 (26.2)
Compressive Stress @ 10% Strain	ASTM D695	psi (MPa)	14000 (96.5)	18500 (127.5)
Compressive Modulus	ASTM D695	psi x 10 <sup>5</sup> (GPa)	2.9 (2.0)	3.8 (2.6)
<b>COEFFICIENT OF THERMAL EXPANSION</b>				
73 to 500°F (23 to 260°C)	ASTM E831	in/in/°F (m/m/°C) x 10 <sup>5</sup>	2.7 (4.9)	2.7 (4.9)
-80 to 73°F (-62 to 23°C)	ASTM E831	in/in/°F (m/m/°C) x 10 <sup>6</sup>	—	—
Thermal Conductivity	ASTM F433	BTU in/hr ft <sup>2</sup> °F (W/m°C)	2.2 (0.31)	2.4 (0.34)
<b>ELECTRICAL</b>				
Dielectric Strength, Short time 2mm (.08") thick	ASTM D149	V/mil (MV/m)	—	580 (22.9)
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 <sup>15</sup> - 10 <sup>16</sup>
<b>OTHER</b>				
Specific Gravity	ASTM D792	—	1.34	1.43
Hardness Rockwell E	ASTM D785	—	—	40 - 55
Water Absorption, 24 hours	ASTM D570	%	—	0.23
Water Absorption, 48 hours	ASTM D570	%	—	0.64
Deformation under Load @ 2000 psi	ASTM D-621	%	0.1	0.1
Limiting Oxygen Index	ASTM D2863	—	—	100
High Temperature Dimensional Stability @ 500°F	INTERNAL	% Change	0.00% Max	—
<b>MECHANICAL PROPERTIES @ 500°F (260°C)</b>				
Tensile Strength	ASTM D638	psi (MPa)	5500 (38)	6250 (43)
Elongation	ASTM D638	%	7.5	5.0
Flexural Strength	ASTM D790	psi (MPa)	7000 (48)	9100 (62.7)
Flexural Modulus	ASTM D790	psi x 10 <sup>5</sup> (GPa)	2 (1.3)	2.5 (1.7)
<b>SPECIFICATION QUALIFICATION</b>				
<b>ASTM D 6456-99</b> Standard Specification for Finished Parts Made from Polyimide Resin		Satisfies →	Type I D	Type I P
<b>AMS SAE 3644G</b> Polyimide, Molded Rod, Bar and Tube, Plaque, and Formed Parts		Satisfies →	Class 1 Form D	Class 1 Form P
<b>MIL-R-46198</b> Resin, Polyimide, Hot Pressed or Pressed and Sintered		Satisfies →	Type I D	Type I P

\*Molding Method Codes: Direct Formed (DF), Compression Molded (CM)

NOTE: See page 6 for properties of isostatically molded material.

MELDIN® 7021		MELDIN® 7022		MELDIN® 7211		MELDIN® 7003
DF	CM	DF	CM	DF	CM	CM
9100 (62.7)	9500 (65.5)	7200 (49.6)	8000 (55)	8000 (55)	7500 (51.7)	9200 (63.4)
5.5	4.7	3.0	3.0	5.4	4.0	5.5
13000 (89.5)	15800 (109)	10500 (72.4)	13000 (89.6)	11000 (75.8)	11800 (81.4)	13000 (89.6)
4.5 (3.0)	5.3 (3.6)	6.7 (4.5)	7.7 (5.2)	4.0 (2.7)	5.0 (3.4)	4.6 (3.1)
3400 (23)	4300 (29.7)	3300 (22.8)	4700 (32.4)	2300 (15.9)	3500 (24)	3700 (25.5)
15300 (106)	1800 (124)	14000 (96.5)	15500 (107)	11200 (77.2)	14950 (103)	17000 (117)
3.0 (2.1)	4.5 (3.1)	2.9 (2.0)	4.8 (3.3)	2.5 (1.7)	3.5 (2.4)	3.6 (2.5)
2.0 (3.6)	2.2 (4.0)	1.1 (2.0)	1.4 (2.5)	2.4 (4.3)	2.4 (4.3)	—
—	—	—	—	—	—	—
3.0 (0.43)	5 (0.71)	—	—	—	5.2 (0.74)	—
—	280 (11)	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	10^8 - 10^9	—	—	—	—	—
1.42	1.51	1.56	1.65	1.45	1.53	1.61
—	25-40	—	5-20	—	1 - 15	—
—	0.19	—	0.25	—	0.23	—
—	0.50	—	0.48	—	0.46	—
0.14	0.1	0.15	—	0.2	—	—
—	100	—	—	—	—	—
0.04% Max	—	0.002% Max	—	0.002% Max	—	—
4700 (32.4)	5700 (39.3)	4000 (27.6)	4500 (31)	4300 (29.7)	4300 (29.7)	—
5.2	3.2	3.0	2.4	5.1	2.8	—
7500 (51.7)	8600 (59.3)	6000 (41.4)	7000 (48.3)	6000 (41.4)	6000 (41.4)	—
2.6 (1.8)	3.5 (2.4)	3.8 (2.6)	5.2 (3.6)	2.7 (1.9)	3.0 (2.1)	—
Type II Class 1D	Type II Class 1P	Type II Class 2D	Type II Class 2P	Type II Class 3D	Type II Class 3P	Type III
Class 2 Form D	Class 2 Form P	Class 3 Form D	Class 3 Form P	Class 4 Form D	Class 4 Form P	Class 5 Form P
Type II Class 1D	Type II Class 1P	Type II Class 2D	Type II Class 2P	Type II Class 3D	Type II Class 3P	Type III

# Typical Properties of Isostatic Meldin® Materials

PROPERTY	ASTM Method	Units	Meldin® 7001	Meldin® 7003	Meldin® 7021	Meldin® 7022	Meldin® 7211
<b>MECHANICAL</b>							
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 <sup>5</sup> (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 <sup>5</sup> (GPa)	2.9 (2.0)	3.63 (2.5)	3.26 (2.3)	4.09 (2.8)	3.34 (2.3)
<b>THERMAL EXPANSION</b>							
75 to 500°F (24 to 260°C)	E-831	in/in/°F x 10 <sup>-5</sup> (m/m/°C)	2.7 (5.0)	2.87 (5.16)	2.5 (4.5)	2.23 (4.0)	2.8 (5.0)
<b>ELECTRICAL</b>							
Dielectric Strength	D149	V/mil (MV/m)	450 (18)	—	104 (4.0)	—	—
<b>OTHER</b>							
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
<b>SPECIFICATION QUALIFICATION</b>							
<b>ASTM D 6456-99</b> 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	
<b>AMS SAE 3644G</b> 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	
<b>MIL-R-46198</b> 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.

# Meldin® 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	V-0, 5VA Tested and Passed			
	V-0, 5VA UL Listed			

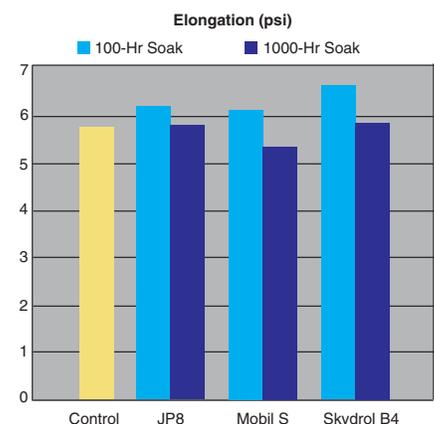
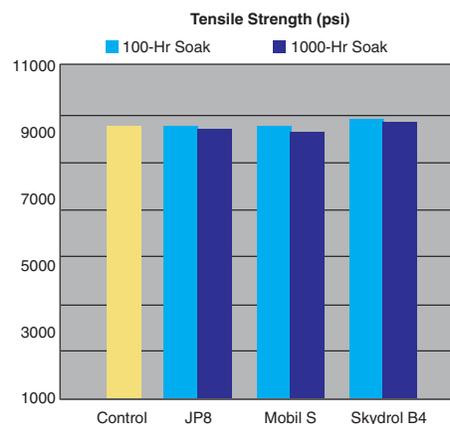
## Meldin® 7021 Aerospace Fluid Tests

### Test Conditions

Measure the tensile strength and % elongation of a control sample and then immersing 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 of 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.

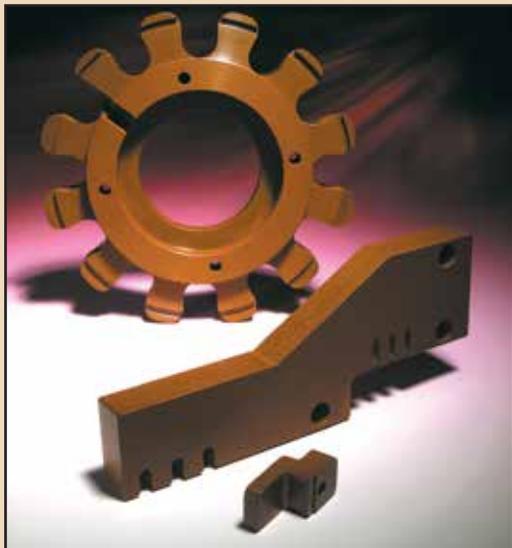


# Applications of Meldin® Thermoset Polyimide Materials



Meldin® 7001 materials are direct formed and machined for use in critical plasma-cutting torches in the torch handle. These torches create high energy vortex gas streams, and Meldin® parts distribute these gases precisely due to their inherent dimensional stability and machinability. Also, other parts in the torch handle insulate high electrical energy from the user, ensuring safe operation. High impact resistance increases the useful life of this equipment as compared to ceramic alternatives.

Our Meldin® 7021 self-lubricating polyimide materials meet or exceed the most stringent requirements for aerospace applications. Backed up by third-party independent testing, the Meldin® 7021 material grade provides our customers with consistent mechanical and performance properties for aircraft airframe systems such as landing gear and fuselage components, as well as jet engine parts such as pads, bumpers, washers, seals, and bearings.



Semiconductor manufacturing customers require process equipment whose materials have high purity, high resistance to solvents, oils, and other process chemicals, and high electrical insulative properties – all combined with the ability to hold dimensional features over a wide temperature range. The Meldin® 7001 unfilled resin grade fulfills all these requirements. Available as finished machined parts or in basic shapes. Ask about our 12" square sheets and specially tailored tubes. Meldin® 7001 will add value to your production.



Self-lubricating grades of Meldin® are used as piston rings and thrust washers in transmissions and pumps for automotive, off-road, agriculture and aerospace, replacing traditional metals in many instances. There are several benefits of using Meldin® series materials instead of the traditional steel materials, such as better conformability, lower leakage, higher P x V ability, lower total part cost (thanks to the very cost-effective Direct Forming process) and emergency dry-running capabilities. By optimizing the design (grooves, type of cut, etc) in house and testing these on our custom-made test benches, we are continuously developing better solutions for the challenges to come in these industries.



Many manufacturing lines throughout the industry use sliding surfaces or sliding transport modules. High-temperature sliding surfaces are to be wear-resistant, self-lubricating, not scratching the parts that slide over them and should, in some cases such as glass handling, not cause stress-cracking to the material due to too rapid cool-down. Meldin® 7021 and Meldin® 7022 can do all of the above and are the industry's choice for high-temperature sliding applications.



Meldin® 7001 is used as a thermal insulator in hot runner nozzles used for injection molding thermoplastics such as PET bottle preforms. Designed and manufactured especially for molding thermoplastics of all kinds, the nozzle tip insulator serves two purposes: thermal insulation of the molten plastic to prevent freeze-off of the plastic while awaiting injection inside the hot runner system, and allowing easy color transfer between production batches, reducing downtime of the tool.

# Customized Engineering Support and Solutions

## Saint-Gobain Seals Sites for Meldin® Thermoset Polyimide Products



Bristol/USA



Kontich/Belgium



Shanghai/China

Saint-Gobain Seals uses its state-of-the-art testing and engineering equipment to support you in your most challenging applications.

### Tribology Test Rigs

Tribology test rigs continuously measure material wear, coefficient of friction, and mating surface temperature over time. A wide range of mating surface materials, surface finishes, and surface hardnesses are available for testing. Test rig options include submerged (wet) testing, as well as externally heated mating surfaces to simulate hot environments.



### Tribological Test Room

Tribology test room can operate 24 hours a day with continuous computer data acquisition.

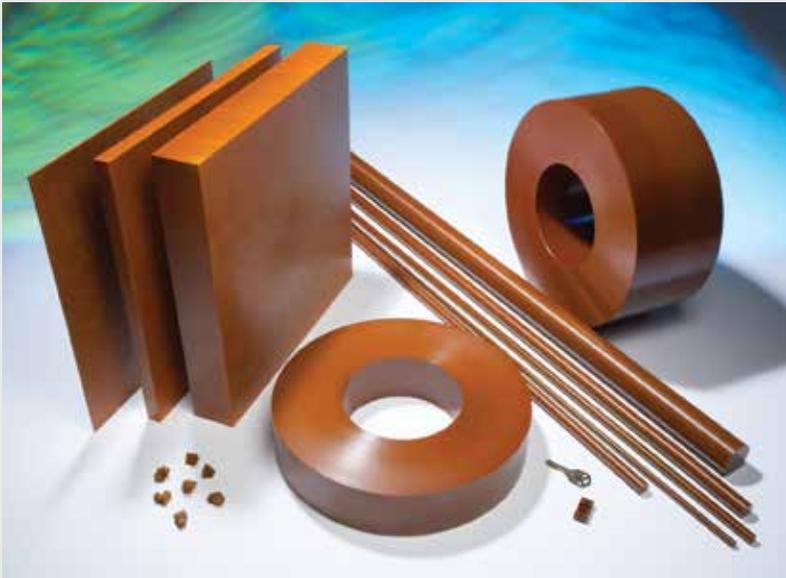
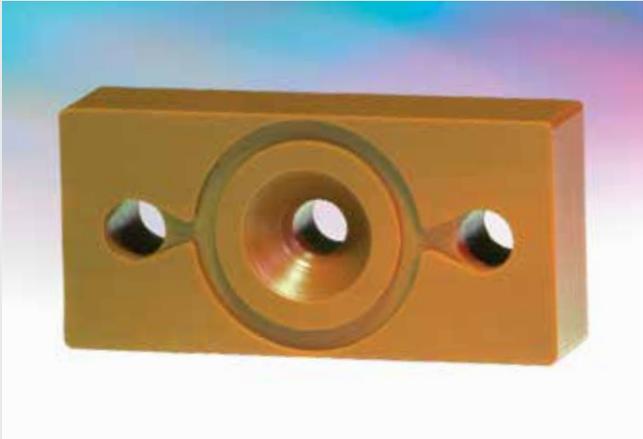


### Rotating Sealing Ring Test Rig

The test rig measures oil leakage, oil pressure, oil temperature and torque, and provides test conditions of elevated oil temperatures up to 300°F (149°C), oil pressures up to 350 psi (24.1 bar), and rotational speeds up to 7000 RPM. The test rig is flexible to handle various housing bore material types and can test rings up to 6" (152.4mm) in diameter.



# Meldin® Thermoset Polyimide Critical Parts and Shapes



Critical parts  
making THE difference 

PRECISE FIT  LIFETIME CONFIDENCE



## A Global Network of Expertise and Service



● Manufacturing and sales locations    ● Sales only locations    ● R&D Centers

### Manufacturing and sales locations

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Parque Industrial Saltillo-Ramos  
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Shanghai, China  
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Phone (mobile): +1-248-420-8918
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Houston, TX USA 77060  
Phone: +1-832-666-2169
-  V.le Colleoni 3  
Palazzo Taurus 2  
20864 Agrate Brianza (MI), Italy  
Phone: +39 039 657891
-  Grindwell Norton Limited  
Devanahalli Road, Via Old Madras Road  
Bangalore, India 560049  
Phone: +91 80 30978888
-  Fuchu South Building 6F,  
1-40 Miyamachi  
Fuchu-City, Tokyo, Japan 183-0023  
Phone: +81 42 352 2100
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