

ISOPLAST* 101



Engineering Thermoplastic Polyurathane Resin

Property	Test Method	English		S.I		
		Values [†]	Units	Values [†]	Units	
PHYSICAL PROPERTIES						
Gardner 60° Gloss	ASTM D 823	100	%	100	%	
Mold Shrinkage	ASTM D 955	0.004-0.006	in/in	0.004-0.006	mm/mm	
Water Absorption, 24 hrs @ 73°F (23°C)	ASTM D 570	0.17	%	0.17	%	
Specific Gravity	ASTM D 792	1.19	----	1.19	----	
MECHANICAL PROPERTIES						
Tensile Strength at Yield	ASTM D 638	7,000	psi	48	MPa	
Tensile Strength at Break	ASTM D 638	7,000	psi	48	MPa	
Elongation at Yield	ASTM D 638	6	%	6	%	
Elongation at Break	ASTM D 638	160	%	160	%	
Tensile Modulus	ASTM D 638	220,000	psi	1,500	MPa	
Flexural Strength	ASTM D 790	9,900	psi	68	MPa	
Flexural Modulus	ASTM D 790	260,000	psi	1,800	MPa	
Izod Impact Strength	ASTM D 256					
Notched, 1/8" (3.2 mm), 73° (23°C)		24	ft-lb/in	1,280	J/m	
Notched, 1/8" (3.2 mm), -40° (-40°C)		3	ft-lb/in	160	J/m	
Notched, 1/4" (6.4 mm), 73° (23°C)		21	ft-lb/in	1,100	J/m	
Instrumented Dart Impact	ASTM D 3763					
Total Energy at 73°F (23°C)		600	in-lb	68	J	
Total Energy at -20°F (-29°C)		600	in-lb	68	J	
Rockwell Hardness	ASTM D 785					
R Scale		116	----	116	----	
M Scale		----	----	----	----	
THERMAL PROPERTIES						
Deflection Temperature Under Load	ADTM D 648					
66 psi (0.45 MPa), unannealed		160	°F	71	°C	
66 psi (0.45 MPa), annealed		180	°F	82	°C	
264 psi (1.8 MPa), unannealed		140	°F	60	°C	
264 psi (1.8 MPa), annealed		170	°F	77	°C	
Vicat Temperature	ADTM D 1525	192	°F	89	°C	
Coefficient of Linear Thermal Expansion	ADTM D 696	4.5	10 ⁻⁵ in/in/°F	8.1	10 ⁻⁵ mm/mm/°C	
OPTICAL						
Light Transmission	ADTM D 1003	----	%	----	%	
Yellowness Index	ADTM D 1925	----	----	----	----	
PROCESSING INFORMATION						
Recommended Drying Temperature		185-195	°F	85-91	°C	
Recommended Melt Temperature		430-470	°F	221-243	°C	
Recommended Mold Temperature		150-180	°F	66-82	°C	

[†]Typical values, not to be construed as specifications. Users should confirm results by their own test.

*Trademark of The Dow Company

NOTICE REGARDING LONG-TERM MEDICAL IMPLANT APPLICATIONS: The Dow Chemical Company does not recommend any medical grade resin or film product for long-term medical implant applications in humans, i.e., for more than 72 hours (except 30 days, for PELLETHANE* polyurethane elastomers). Further, Dow does not recommend the use of any resin (or film) product in cardiac prosthetic devices regardless of the time period that the device will be wholly or partially implanted in the body. Such applications include, but are not limited to, pacemaker leads and devices, cardiac prosthetic devices such as artificial hearts, heart valves, intra-aortic balloons and control systems, and ventricular bypass assist devices. Dow does not recommend any nonmedical grade resin (or film) product for use in any human implant applications.

For additional information call The Dow Chemical Company at 1-800-232-2436.

ISOPLAST* 101 LGF40 NAT

Engineering Thermoplastic Polyurathane Resin

Property	Test Method	English		S.I	
		Values†	Units	Values†	Units
PHYSICAL PROPERTIES					
Mold Shrinkage	ASTM D 955	0.001	in/in	0.001	mm/mm
Water Absorption, 24 hrs @ 73°F (23°C)	ASTM D 570	----	%	----	%
Specific Gravity	ASTM D 792	1.51	----	1.51	----
MECHANICAL PROPERTIES					
Tensile Strength at Yield	ASTM D 638	27,000	psi	186	MPa
Tensile Strength at Break	ASTM D 638	27,000	psi	186	MPa
Elongation at Yield	ASTM D 638	2	%	2	%
Elongation at Break	ASTM D 638	2	%	2	%
Tensile Modulus	ASTM D 638	1,700,000	psi	12,000	MPa
Flexural Strength	ASTM D 790	45,000	psi	310	MPa
Flexural Modulus	ASTM D 790	1,500,000	psi	10,000	MPa
Izod Impact Strength	ASTM D 256				
Notched, 1/8" (3.2 mm), 73° (23°C)		8	ft-lb/in	427	J/m
Notched, 1/8" (3.2 mm), -40° (-40°C)		8	ft-lb/in	427	J/m
Instrumented Dart Impact	ASTM D 3763				
Total Energy at 73°F (23°C)		270	in-lb	31	J
Total Energy at -20°F (-29°C)		150	in-lb	17	J
THERMAL PROPERTIES					
Deflection Temperature Under Load	ADTM D 648				
66 psi (0.45 MPa), unannealed		----	°F	----	°C
66 psi (0.45 MPa), annealed		----	°F	----	°C
264 psi (1.8 MPa), unannealed		200	°F	93	°C
264 psi (1.8 MPa), annealed		210	°F	99	°C
Vicat Temperature	ADTM D 1525	366	°F	186	°C
Coefficient of Linear Thermal Expansion	ADTM D 696	0.8	10 ⁻⁵ in/in/°F	1.4	10 ⁻⁵ mm/mm/°C
PROCESSING INFORMATION					
Recommended Drying Temperature		180-210	°F	82-99	°C
Recommended Melt Temperature ⁽¹⁾		460-500	°F	238-260	°C
Recommended Mold Temperature		150-190	°F	66-88	°C

†Typical values, not to be construed as specifications. Users should confirm results by their own test.

⁽¹⁾Under no circumstances should glass reinforced resins be heated above 500°F (260°C) during molding or purging. This might cause decomposition, leaving a glass-enriched melt which cannot be extruded, and therefore, could seize the screw.

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For additional information call The Dow Chemical Company at 1-800-232-2436.

ISOPLAST* 101 LGF40 BLK

Engineering Thermoplastic Polyurathane Resin

Property	Test Method	English		S.I.	
		Values†	Units	Values†	Units
PHYSICAL PROPERTIES					
Mold Shrinkage	ASTM D 955	0.001	in/in	0.001	mm/mm
Water Absorption, 24 hrs @ 73°F (23°C)	ASTM D 570	----	%	----	%
Specific Gravity	ASTM D 792	1.51	----	1.51	----
MECHANICAL PROPERTIES					
Tensile Strength at Yield	ASTM D 638	27,000	psi	186	MPa
Tensile Strength at Break	ASTM D 638	27,000	psi	186	MPa
Elongation at Yield	ASTM D 638	2	%	2	%
Elongation at Break	ASTM D 638	2	%	2	%
Tensile Modulus	ASTM D 638	1,500,000	psi	10,000	MPa
Flexural Strength	ASTM D 790	36,000	psi	248	MPa
Flexural Modulus	ASTM D 790	1,400,000	psi	9,600	MPa
Izod Impact Strength	ASTM D 256				
Notched, 1/8" (3.2 mm), 73° (23°C)		6	ft-lb/in	320	J/m
Notched, 1/8" (3.2 mm), -40° (-40°C)		6	ft-lb/in	320	J/m
Instrumented Dart Impact	ASTM D 3763				
Total Energy at 73°F (23°C)		----	in-lb	----	J
Total Energy at -20°F (-29°C)		----	in-lb	----	J
THERMAL PROPERTIES					
Deflection Temperature Under Load	ADTM D 648				
66 psi (0.45 MPa), unannealed		----	°F	----	°C
66 psi (0.45 MPa), annealed		----	°F	----	°C
264 psi (1.8 MPa), unannealed		200	°F	93	°C
264 psi (1.8 MPa), annealed		210	°F	99	°C
Vicat Temperature	ADTM D 1525	366	°F	186	°C
Coefficient of Linear Thermal Expansion	ADTM D 696	0.8	10 ⁻⁵ in/in/°F	1.4	10 ⁻⁵ mm/mm/°C
PROCESSING INFORMATION					
Recommended Drying Temperature		180-210	°F	82-99	°C
Recommended Melt Temperature ⁽¹⁾		460-500	°F	238-260	°C
Recommended Mold Temperature		150-190	°F	66-88	°C

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For additional information call The Dow Chemical Company at 1-800-232-2436.

Chemical Resistance of 40% Long Glass Fiber Polyurethane

Test Procedures

All tests were conducted by immersing an injection-molded, 0.125-inch thick sample of the chemical. Unless otherwise indicated, the samples were exposed for 28 days at 73F, then were removed and tested.

Chemical	Change in Weight (%)	Strength at Yield (%)	Elongation at Yield (%)	Modulus
Acetic Acid, 5%	+0.7	90	96	88
Acetic Acid, 20%	+0.7	96	98	-
Acetic Acid, glacial	+5.3	82	106	80
Ammonia, concentrated	+1.0	86	86	97
ANDEROL, 401 Lubricant	-	119	87	-
ASTM Fuel A	+0.2	103	97	-
ASTM Fuel B	+0.2	101	97	-
ASTM Fuel C	+0.2	101	100	-
ASTM #1 Oil	+0.2	111	103	-
ASTM #3 Oil	+0.3	101	102	-
Benzene	+1.4	89	100	93
Calcium Chloride, saturate	+0.4	103	97	-
Carbon Tetrachloride	+0.2	98	98	103
Clorox Bleach	+0.5	93	94	102
Cottonseed Oil	+0.2	106	94	102
Dioctyl Phthalate	+0.2	106	97	-
Ethanol, 50%	+1.0	91	98	92
Ethanol, 95%	+2.5	83	98	84
Ethylene Glycol, 100%	-0.3	103	110	98
Ethylene Glycol, 50%	+0.3	94	100	94
Freon Fluorocarbon	0	105	91	-
Gasoline, high test	+0.1	101	102	-
Heptane	0	102	100	103
Hydrochloric, Acid, 20%	+0.2	96	96	96
Hydrogen Peroxide, 3%	+0.6	92	90	84
Hydrogen Peroxide, 30%	+0.8	90	96	96
Isopropanol	+0.2	100	106	99
Kerosene	-0.1	101	96	104
Magnesium Chloride, saturated	-	128	141	-
Mineral Oil	+0.2	101	98	-
Motor Oil, 10W40	+0.3	101	100	-
Mr. Clean Cleaner	+0.7	93	98	-
Nitric Acid, 40%	+1.1	95	102	94
Perchloroethane	+0.6	102	102	109
Phosphoric Acid, 60%	+0.6	99	100	-
Sodium Chloride, 10%	+0.2	92	92	90
Sodium Hydroxide, 10%	+0.3	94	94	108
Sodium Hydroxide, 20%	+0.6	98	100	-
Sulfuric Acid, 20%	+0.5	97	98	-
Sulfuric Acid, 30%	+0.3	97	93	97
Sulfuric Acid, 70%	-0.1	101	102	100
Toluene	+1.5	97	98	111
Transmission Fluid, Type A	+0.2	101	103	-
Tricresyl Phosphate	0	106	102	-
Triethylamine	-0.2	104	104	104
Water, distilled	+0.6	89	92	106
Water, distilled*	+1.5	106	110	-
Water, sea	+0.8	92	97	-
Zinc Chloride, 50%**	-	106	102	104

* 28 days at 158F

** 21 days at 73F.

NOMINAL PHYSICAL PROPERTIES



Property	Units	Grades		
		R-4*	R-4XT*	R-7*
Density	g/cc	1.65	1.65	1.90
Water Absorption	%	0.05	0.05	0.03
Tensile Strength	Ksi	22.0	28.0	18.5
Elongation	%	1.2	1.7	0.8
Weld Line Tensile	Ksi	6.0	11.5	6.4
Flexural Strength	Ksi	29.5	40.5	27.0
Flexural Modulus	Msi	2.1	2.2	2.3
Compressive Strength	Ksi	26.0	34.0	25.0
Izod Impact Strength, 1/8 in Specimen	ft.lbf/in			
Notched		1.7	1.7	1.2
Unnotched		6.0	10.5	4.5
Rockwell Hardness		R122	R122	R121
Heat Deflection Temperature @264 psi	°F	>500**	>500**	>500**
UL Temperature Index	°C	200/220	200/220	200/220
Coefficient Linear Thermal Expansion***	um/m/°C			
Axial Direction		17	17	17
Transverse Direction		35	40	31
Thermal Conductivity	BTU-in/h-ft ² -°F	2.1	2.2	4.0
Oxygen Index	%	47	56.5	53
Flammability Rating,	UL94	V-0/5VA	V-0/5VA	V-0/5VA
Dielectric Strength	V/mil	450	500	450
Dielectric Constant, (78°F)				
1kHz		3.9	4.0	5.1
1MHz		3.8	3.9	4.0
Dissipation Factor, (78°F)				
1kHz		0.002	0.002	0.058
1MHz		0.0014	0.004	0.0088
Volume Resistivity	ohm-cm	1.0x10 ¹⁶	1.0x10 ¹⁶	5x10 ¹⁵
Arc Resistance	sec	34	130	167
Arc Tracking Rate	in/min	7.1	5.2	0
Comparative Tracking Index	V	130	130	225
Accelerated Insulation Resistance	ohm	1x10 ¹¹	1x10 ¹¹	1x10 ¹¹

*Test specimen molding conditions:
Stock Temperature, 600 - 650°F;
Mold Temperature, 275°F

**Annealed 2 hrs 400°F
***-50°C to 50°C

PRODUCT OVERVIEW

Ryton® PPS (Polyphenylene sulfide) is an exceptionally strong, thermally stable, corrosion resistant engineering thermoplastic from Phillips Chemical Company. Ryton® PPS retains structural integrity under the most demanding conditions of temperature and physical abuse - and offers an outstanding cost/performance value.

Excellent temperature resistance

In continuous-service applications, Ryton® PPS boasts UL temperature indices up to 240°C with outstanding dimensional stability, and it can withstand short-term exposures to temperatures greater than 500°F Plus, it is inherently flame retardant and exhibits low smoke emission and nontoxic gas generation.

Virtually no corrosion

Ryton® PPS is resistant to a broad spectrum of solvents, organic acids and alkalis. In fact, there are no known organic solvents for Ryton® PPS at temperatures below 400°F!

Better, all-around value

Shorter processing times, no special storage requirements, elimination of machining during manufacturing and easier recycling of scrap allow Ryton® PPS to economically replace a number of engineering materials.

Its low creep, high moisture resistance, outstanding warp resistance, high tensile strength and high flexural modulus can lead to substantially longer service life, making Ryton® PPS an outstanding performance investment.

Data from Phillips Chemical Company.
For additional information call: 800-53-RESIN.

ULTEM® Polyetherimide

An amorphous thermoplastic polyetherimide, ULTEM resin combines the high performance usually associated with exotic specialty plastics and the excellent processing characteristics typical of engineering plastics. With this balance of superior properties and processability, ULTEM polyetherimide offers the engineer exceptional design freedom in applications which require:

- High heat resistance.
- Exceptional strength and modulus.
- Inherent flame resistance with low smoke evolution.
- High dielectric strength.
- Stable dielectric constant and dissipation factor over a wide range of temperatures and frequencies.
- Broad chemical resistance.
- Transparency.
- Outstanding processability on conventional molding equipment.
- Excellent machinability and finishing characteristics.

TYPICAL PROPERTIES ENGLISH UNITS (SI UNITS)	UNREINFORCED		GLASS REINFORCED	
	ENG (SI) UNITS	ASTM TEST METHOD	ULTEM 1000 resin	ULTEM 2300/2310 30% GR resin
MECHANICAL PROPERTIES				
Tensile Strength, yield, Type 1, 0.125" (3.2mm)	psi(MPa)	D 638	15200(105)	24,500(170)
Tensile Elongation, yield, Type 1, 0.125" (3.2mm)	%	D 638	7.0	----
Tensile Elongation, break, Type 1, 0.125" (3.2mm)	%	D 638	60	3.0
Tensile Modulus, Type 1, 0.125" (3.2mm)	psi(MPa)	D 638	----	1,260,000(8,700)
Flexural Strength, yield, 0.125" (3.2mm)	psi(MPa)	D 790	22,000(150)	----
Flexural Strength, break, 0.125" (3.2mm)	psi(MPa)	D 790	----	33,000(230)
Flexural Modulus, Type 1, 0.125" (3.2mm)	psi(MPa)	D 790	480,000(3,300)	1,300,000(9,000)
Compressive Strength	psi(MPa)	D 695	21,900(150)	30,700(210)
Compressive Modulus	psi(MPa)	D 695	480,000(3,300)	938,000(6,500)
Shear Strength	psi(MPa)	D 732	15,000(100)	14,000(100)
Hardness, Rockwell M	----	D 785	109	114
Taber Abrasion, CS-17, 1 kg	mg/1000 cy	D 1044	10	----
IMPACT PROPERTIES				
Izod Impact, unnotched, 73F (23C)	ft-lb/in(J/m)	D 256	25.0(1,300)	8.0(430)
Izod Impact, notched, 73F (23C)	ft-lb/in(J/m)	D 256	1.0(50)	2.0(110)
Izod Impact, reverse notched, 0.125" (3.2mm), 73F (23C)	ft-lb/in(J/m)	D 256	----	7.5(400)
Gardner Impact, 73F (23C)	ft-lb(J)	D 3029	27(37)	----
THERMAL PROPERTIES				
Vicat Softening Temperature, Rate B	deg F(deg C)	D 1525	426(219)	442(228)
HDT, 66 psi (0.45 MPa), 0.250" (6.4mm), unannealed	deg F(deg C)	D 648	410(210)	414(212)
HDT, 264 psi (1.82 MPa), 0.250" (6.4mm), unannealed	deg F(deg C)	D 648	392(200)	410(210)
Thermal Conductivity	W/m-C	C 177	0.22	----
CTE flow X E-5, -40F to 100F (-40C to 38C)	in/in-F(m/m-C)	E 831	----	----
CTE flow X E-5, 0F to 300F (-20C to 150C)	in/in-F(m/m-C)	E 831	3.1(5.6)	1.1(2.0)
CTE xflow X E-5, 0F to 300F (-20C to 150C)	in/in-F(m/m-C)	E 831	3.0(5.4)	----
Thermal Index, Elec Prop	deg C	UL746B	170	180
Thermal Index, Mech Prop with impact	deg C	UL746B	170	170
Thermal Index, Mech Prop without impact	deg C	UL746B	170	180

(Continued on pg 306)

* This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

^aSame value for flow.

ULTEM[®] Polyetherimide

TYPICAL PROPERTIES ENGLISH UNITS (SI UNITS)	UNREINFORCED		GLASS REINFORCED	
	ENG (SI) UNITS	ASTM TEST METHOD	ULTEM 1000 resin	ULTEM 2300/2310 30% GR resin
PHYSICAL PROPERTIES				
Specific Gravity, Solid	----	D 792	1.27	1.51
Water Absorption, 24 hrs @ 73F (23C)	%	D 570	0.25	0.16
Water Absorption, equilibrium @ 73F (23C)	%	D 570	1.25	0.90
Mold Shrinkage, flow, 0.125" (3.2mm)	in/in E-3	D 955	5-7	2-4 ^a
Poisson's Ratio	----	D 638	0.36	----
ELECTRICAL PROPERTIES				
Volume Resistivity	ohm-cm(ohm-m)	D 257	1.0E17(1.0E15)	3.0E16(3.0E14)
Dielectric Strength, in air, 62 mils (1.6mm)	V/mil(kV/mm)	D 149	831(33)	770(30)
Dielectric Strength, in oil, 62 mils (1.6mm)	V/mil(kV/mm)	D 149	710(28)	630(25)
Dielectric Strength, in oil, 125 mils (3.2mm)	V/mil(kV/mm)	D 149	500(20)	----
Dielectric Constant, 100Hz	----	D 150	3.15	----
Dielectric Constant, 1 kHz	----	D 150	3.15	3.7
Dissipation Factor, 100Hz	----	D 150	0.0015	----
Dissipation Factor, 1 kHz	----	D 150	0.0012	0.0015
Dissipation Factor, 2,450 MHz	----	D 150	0.0025	0.0053
Arc Resistance, Tungsten	sec	D 495	----	85
FLAME CHARACTERISTICS				
UL94V-O Flame Class Rating*	in(mm)	UL94	0.016(0.41)	0.010(0.25)
UL94-5VA Flame Class Rating*	in(mm)	UL94	0.075(1.9)	----
Oxygen Index (LOI)	%	D 2863	47	50.0
NBS Smoke Density, flaming, Ds 4 min.	----	E 662	0.7	1.6
NBS Smoke Density, flaming, Dmax 20 min.	----	E 662	30	20.0
NBS Smoke Density, smolder, Dmax 20 min.	----	E 662	----	20.0

(Continued from pg 305)

* This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

^aSame value for flow.



For Additional Information Call:
General Electric Company
1-800-845-0600

NORYL®



NORYL® engineering thermoplastic resin is based on polyphenylene ether PPE (made and sold by GE Plastics under the trademark, PPO®). PPE, a high-heat amorphous polymer, forms a miscible, single-phase blend with polystyrene. This technology, in combination with other additives, provides a family of resins covering a wide range of physical and thermomechanical properties. General characteristics include high heat resistance, excellent electrical properties, hydrolytic stability, dimensional stability and very low creep behavior at elevated temperatures.

Versatile NORYL resins are used in an extensive variety of applications such as computer and business equipment, electrical and electronic devices, telecommunications, appliances, water handling equipment and automotive applications.

NORYL resin has been especially noted for its outstanding hydrolytic stability. Low water absorption rates - both at room temperature and at elevated temperatures - promote the retention of properties and dimensional stability in the presence of water, high humidity and even steam environments. In addition, NORYL resin is also virtually unaffected by a wide variety of aqueous solutions, detergents, acids and bases.

Typical Properties	ENG (SI) UNITS	TEST METHOD	NORYL GFN2 20% GR resin	NORYL GFN3 30% GR resin
MECHANICAL PROPERTIES				
Tensile Strength, yield, Type I, 0.125" (3.2mm)	psi(MPa)	ASTM D 638	13,000(90)	15,000(103)
Tensile Elongation, break, Type I, 0.125" (3.2mm)	%	ASTM D 638	5.0	5.0
Flexural Strength, yield, 0.250" (6.4mm)	psi(MPa)	ASTM D 790	21,000(145)	23,500(162)
Flexural Modulus, 0.250" (6.4mm)	psi(MPa)	ASTM D 790	767,000(5,285)	1,040,000(7,166)
Hardness, Rockwell L	----	ASTM D 785	106	108
IMPACT				
Izod Impact, notched, 73°F (23°C)	ft-lb/in(J/m)	ASTM D 256	2.0(107)	2.2(117)
Izod Impact, notched, -40°F (-40°C)	ft-lb/in(J/m)	ASTM D 256	1.8(96)	1.8(96)
THERMAL PROPERTIES				
HDT, 66 psi (0.45 MPa), 0.250" (6.4mm), unannealed	°F(°C)	ASTM D 648	293(145)	317(158)
HDT, 264 psi (1.82 MPa), 0.250" (6.4mm), unannealed	°F(°C)	ASTM D 648	280(138)	280(138)
CTE, flow, -40°F to 200°F (-40°C to 93°C)	in/in-°(m/m-°C)	ASTM E 831	2.0E-5(3.6 E-5)	1.4 E-5(2.5 E-5)
Relative Thermal Index, Elec Prop	°C	UL746B	90	90
Relative Thermal Index, Mech Prop with impact	°C	UL746B	90	90
Relative Thermal Index, Mech Prop without impact	°C	UL746B	90	90
PHYSICAL PROPERTIES				
Specific Gravity, solid	----	ASTM D 792	1.20	1.28
Water Absorption, 24 hours @ 73°F (23°C)	%	ASTM D 570	0.060	0.060
Mold Shrinkage, flow, 0.125" (3.2mm)	in/in E-3	ASTM D 965	2-5	1-4
ELECTRICAL PROPERTIES				
Dielectric Strength, in oil, 125 mils (3.2mm)	V/mil(kV/mm)	ASTM D 149	420(17)	550(22)
Dielectric Constant, 60Hz	----	ASTM D 150	2.86	2.93
Dielectric Constant, 1 MHz	----	ASTM D 150	----	----
Dissipation Factor, 60 Hz	----	ASTM D 150	0.0008	0.0009
Dissipation Factor, 1 MHz	----	ASTM D 150	----	----
FLAME CHARACTERISTICS*				
UL File Number, USA	File No.	E121562	E121562	E121562
UL 94HB Flame Class Rating (tested thickness)	in(mm)	UL 94	0.058(1.47)	0.058(1.47)
CSA (See file for Complete Listing)	File No.	CSA Listed	----	LS8840
Oxygen Index (LOI)	%	ASTM D 2863	26.0	26.0

For Additional Information Call: General Electric Company 1-800-845-0600

RADEL[®] A POLYETHERSULFONE

RADEL A-100, A-200, and A-300 Engineering Resins

RADEL A polyethersulfone resins offer high heat deflection temperatures, excellent toughness and dimensional stability, and superior resistance to steam, boiling water, and mineral acids. Other desirable properties include thermal stability, creep resistance, and inherent flame resistance. Three melt flow grades are available. A-100 is the low melt flow grade for extrusion. A-300, with the highest melt flow, is the general purpose injection molding grade. A-200 is a medium viscosity grade that can be used for either extrusion or injection molding. All three grades are transparent and injection-moldable to close tolerances.

TYPICAL PROPERTIES OF RADEL A-100, A-200, and A-300 RESINS

	ASTM Test Method	TYPICAL VALUES ⁽¹⁾			
		U.S. Customary Units		SI Units	
		Value	Units	Value	Units
GENERAL PROPERTIES					
Specific Gravity	D 792	1.37	----	1.37	----
Water Absorption, 24 hours	D 570	0.54	%	0.54	%
MECHANICAL PROPERTIES					
Tensile Strength	D 638	12,000	psi	83	MPa
Tensile Modulus	D 638	385,000	psi	2.6	GPa
Tensile Elongation at Yield	D 638	6.5	%	6.5	%
Flexural Strength	D 790	16,100	psi	111	MPa
Flexural Modulus	D 790	420,000	psi	2.9	GPa
Tensile Impact Strength	D 1822	160	ft-lb/in ²	336	kJ/m ²
Izod Impact Strength	D 256	1.6	ft-lb/in	85	J/m
THERMAL PROPERTIES					
Deflection Temperature at 264 psi (1.82 MPa)	D 648	400	°F	204	°C
Flammability Rating ⁽²⁾ at 0.031 in. (0.79 mm)	UL-94	V-0	----	V-0	----
Relative Thermal Index	UL-746B				
Electrical at 0.031 in. (0.79 mm)		356	°F	180	°C
Mechanical with impact at 0.062 in. (1.57 mm)		356	°F	180	°C
Coefficient of Thermal Expansion	D 696	2.7 x 10 ⁻⁵	in/in°F	4.9 x 10 ⁻⁵	mm/mm°C
ELECTRICAL PROPERTIES AND FABRICATION					
Dielectric Strength	D 149	380	V/mil	15	kV/mm
Dielectric Constant					
@ 60 Hz	D 150	3.51	----	3.51	----
@ 10 ³ Hz		3.50	----	3.50	----
@ 10 ⁶ Hz		3.54	----	3.54	----
Dissipation Factor					
@ 60 Hz	D 150	0.0017	----	0.0017	----
@ 10 ³ Hz		0.0022	----	0.0022	----
@ 10 ⁶ Hz		0.0056	----	0.0056	----
Volume Resistivity	D 257	1.7 x 10 ⁻¹⁵	ohm-cm	1.7 x 10 ⁻¹⁵	ohm-cm
Melt Flow at 380°C (716°F), 44 psi	D 1238				
A-100		12.5	g/10 min	12.5	g/10min
A-200		20	g/10 min	20	g/10 min
A-300		30	g/10 min	30	g/10 min
Mold Shrinkage	D 955	0.006	in/in	0.006	mm/mm

¹ Actual properties of individual batches will vary within specifications limits. Properties are typical of uncolored resins. Colorants or other additives may alter properties.

² These flammability ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions.

RADEL® A POLYETHERSULFONE



RADEL AG-320, AG-330 Engineering Resins

RADEL AG-320 and AG-330 resins are 20 and 30% glass fiber reinforced polyethersulfone compounds. Adding glass fiber to RADEL A-300 polyethersulfone substantially increases the rigidity, tensile strength, creep resistance, dimensional stability, and chemical resistance, dimensional stability, and chemical resistance of the material, while maintaining most of its other basic characteristics. The combination of structural properties and cost effectiveness make these resins attractive alternatives to metals in many engineering applications. RADEL AG-320 and AG-330 resins can be fabricated with conventional injection molding equipment. They are opaque, grayish materials in their natural form and may be readily colored.

TYPICAL PROPERTIES OF RADEL AG-320 and AG-330 RESINS

	ASTM Test Method	TYPICAL VALUES ⁽¹⁾					
		U.S. Customary Units			SI Units		
		AG-320	AG-330	Units	AG-320	AG-330	Units
MECHANICAL PROPERTIES							
Tensile Strength	D 638	15.8	18.9	kpsi	109	130	MPa
Tensile Elongation	D 638	3.2	1.9	%	3.2	1.9	%
Tensile Modulus	D 638	825	1,250	kpsi	5.69	8.62	GPa
Flexural Strength	D 790	23.5	26.0	kpsi	162	180	MPa
Flexural Modulus	D 790	950	1,250	kpsi	6.55	8.62	GPa
Notched Izod	D 256	1.1	1.4	ft-lb/in	59	75	J/m
Tensile Impact	D 1822	31	34	ft-lb/in ²	65	72	kJ/m ²
THERMAL PROPERTIES							
Deflection Temperature ³ at 264 psi (1.8 MPa)	D 648	400	404	°F	204	207	°C
Coefficient of Thermal Expansion	D 696	1.7 x 10 ⁻⁵	1.7 x 10 ⁻⁵	in/in°F	3.1 x 10 ⁻⁵	3.1 x 10 ⁻⁵	m/m°C
Flammability Rating ² at thickness	UL 94	V0	V0	0.031 in	V0	V0	0.8mm
ELECTRICAL PROPERTIES							
Volume Resistivity	D 257	>10 ¹⁶	>10 ¹⁶	ohm-cm	>10 ¹⁶	>10 ¹⁶	ohm-cm
Dielectric Strength	D 149	440	440	V/mil	17	17	kV/mm
Dielectric Constant							
@ 60 Hz	D 150	3.84	4.11	----	3.84	4.11	----
@ 10 ³		3.84	4.13	----	3.84	4.13	----
@ 10 ⁶		3.88	4.17	----	3.88	4.17	----
Dissipation Factor							
@ 60 Hz	D150	0.0015	0.0019	----	0.0015	0.0019	----
@ 10 ³ Hz		0.0018	0.0018	----	0.0018	0.0018	----
@ 10 ⁶ Hz		0.0081	0.0094	----	0.0081	0.0094	----
GENERAL PROPERTIES							
Specific Gravity	D 1505	1.51	1.58	----	1.51	1.58	----
Water Absorption, 24 hours	D 570	0.45	0.39	%	0.45	0.39	%
Melt Flow at 650°F (343°C)	D 1238	6	4.5	g/10 min	6	4.5	g/10 min
Mold Shrinkage	D 955	0.4	0.3	%	0.4	0.3	%

¹ Properties of individual batches will vary within specification limits. Properties are typical of uncolored material. Colorants or other additives may alter properties.

² These flammability ratings are not intended to

reflect hazards presented by these or any material under actual fire conditions.

³ As molded, not annealed, 0.125 in. (3.2 mm) bar thickness.



BP Amoco Chemicals



For additional information call 1-800-621-4557.

RADEL[®] R POLYPHENYSULFONE

RADEL R-5000, R-5100 NT15, R-5500 Engineering Resins

RADEL R polyphenylsulfone resins offer exceptional hydrolytic stability, and toughness that is superior to other commercially-available, high-temperature engineering resins. They offer high deflection temperatures and outstanding resistance to environmental stress cracking. The polymer is inherently flame retardant, and also has excellent thermal stability and good electrical properties. RADEL R resins are available as an opaque general purpose injection molding grade-R-5100 NT15, a transparent extrusion grade-R-5500.

TYPICAL PROPERTIES OF RADEL R-5000, R-5100 NT15, and R-5500 RESINS

	ASTM Test Method	TYPICAL VALUES ⁽¹⁾			
		U.S. Customary Units		SI Units	
		Value	Units	Value	Units
MECHANICAL PROPERTIES					
Tensile Strength	D 638	10,100	psi	70	MPa
Tensile Modulus	D 638	340,000	psi	2.3	GPa
Tensile Elongation at Yield	D 638	7.2	%	7.2	%
Tensile Elongation at Break	D 638	60-120	%	60-120	%
Flexural Strength ⁽²⁾	D 790	13,200	psi	91	MPa
Flexural Modulus	D 790	350,000	psi	2.4	GPa
Tensile Impact Strength	D 1822	190	ft-lb/in ²	400	kJ/m ²
Izod Impact, Notched	D 256	13	ft-lb/in	690	J/m
THERMAL PROPERTIES					
Deflection Temperature at 264 psi (1.82 MPa)	D 648	405	°F	207	°C
Flammability Rating ⁽³⁾	UL-94	V-0	0.030 in	V-0	0.75 mm
Coefficient of Thermal Expansion	D 696	3.1	10 ⁻⁵ in/in°F	5.6	10 ⁻⁵ mm/mm°C
Glass Transition Temperature ⁽⁴⁾		428	°F	220	°C
ELECTRICAL PROPERTIES					
Dielectric Strength at 0.125 in. (3.2 mm) at 0.001 in. (0.02 mm)	D 149	380	V/mil	15	kV/mm
		>5,000	V/mil	>200	kV/mm
Dielectric Constant at 60 Hz	D 150	3.44	----	3.44	----
Volume Resistivity	D 257	9 x 10 ¹⁵	ohm-cm	9 x 10 ¹⁵	ohm-cm
CHEMICAL PROPERTIES					
Steam Sterilization ⁽⁵⁾ w/ Morpholine, cycles passed without cracking, crazing, or rupture		>1000	cycles	>1000	cycles
Water Absorption at 24 hours	D 570	0.37	%	0.37	%
Water Absorption at Equilibrium	D 570	1.10	%	1.10	%
GENERAL AND FABRICATION		R-5000	R-5100 NT15	R-5500	
Specific Gravity	D 792	1.29	1.30	1.29	
Refractive Index	D 542	1.672	opaque	1.672	
Melt Flow at 752°F (400°C), 44 psi (0.3 MPa), g/10 min	D 1238	17	17	11.5	
Mold Shrinkage, %	D 955	0.7	0.7	0.7	

⁽¹⁾ Actual properties of individual batches will vary within specification limits. Unless otherwise specified, properties were measured using one-eighth inch (3.2mm) thick injection molded specimens.

⁽²⁾ at 5% strain

⁽³⁾ These flammability ratings are not intended to reflect hazards presented by these or any other

materials under actual fire conditions.

⁽⁴⁾ Measured by differential scanning calorimetry at a heating rate of 36°F (20°C) per minute.

⁽⁵⁾ Steam Autoclave Conditions: Temperature - 270°F 132°C; Time - 30 minutes/cycle; Steam Pressure - 27 psig 0.19 MPa; Stress Level - 1000 psi 7.0 Mpa) in flexure; Additive - Morpholine at 50 ppm.



BP Amoco Chemicals



For additional information call 1-800-621-4557.

RADEL® CHEMICAL RESISTANCE

In general, the polysulfone resins have reasonably good chemical resistance, especially to aqueous systems. Table below gives a general indication of the relative chemical resistance to a variety of common reagents. The resistance of both the polysulfone family of resins and the polyetherimide resin to aqueous acids is excellent. The polysulfones also resist aqueous caustic solutions which severely attack the polyetherimide.

With regard to chlorinated hydrocarbons, UDEL polysulfone is severely attacked, RADEL A polyethersulfone and polyetherimide are attacked to a lesser degree while RADEL R polyphenylsulfone shows excellent resistance.

Oxygenated solvents, such as ketones and ethers, attack both the polysulfones and the polyetherimide. Although RADEL R polyphenylsulfone exhibits the best resistance, in general, it would not be considered suitable for use in continuous exposure to these materials.

Aromatic solvents, generally, attack polysulfones and polyetherimide, but RADEL R resins do resist attack best.

Because screening tests indicate that RADEL R polyphenylsulfone has exceptional chemical resistance, more extensive testing was performed. Samples of RADEL R polyphenylsulfone were immersed in a variety of reagents for seven days at room temperature. The effects of the exposure were monitored by measuring any change in weight and noting any change in appearance. To summarize those results, RADEL R polyphenylsulfone is not seriously affected by organic chemicals, except for ketones. Of the inorganic chemicals tested, only concentrated strong acids had a deleterious effect. Several functional fluids common in transportation were tested. Of these only Skyfrol 500A showed crazing.

General Indication of Chemical Resistance

Reagent	UDEL polysulfone	RADELA polyethersulfone	RADEL R polyphenylsulfone	PEI polyetherimide
n-Butane	G	E	E	E
Iso-octane	G	E	E	E
Benzene	SA	SA	F	SA
Toluene	SA	SA	F	SA
Ethanol	G	G	E	E
Methyl Ethyl Ketone	SA	SA	F	F
2-Ethoxyethanol	SA	SA	SA	SA
1, 1, 1 -Trichloroethane	SA	SA	G	SA
Carbon Tetrachloride	SA	G/E	E	E
Hydrochloric Acid (20 %)	E	E	E	E
Acetic Acid (20 %)	E	E	E	E
Sulfuric Acid (20 %)	E	E	E	E
Sodium Hydroxide 10 %	E	E	E	SA

Exposure - immersion for seven days at room temperature.

Rating System:	E	Excellent	No change
	G	Good	Minor attack, no serious loss of properties
	F	Fair	Some attack, but still has useful properties
	SA	Severe Attack	Severe attack or rupture

For additional information call 1-800-621-4557.