

General information

Designation

Phenol formaldehyde (High Strength Glass Fiber, Molding)

Tradenames

Bakelite; Durez; Ferroreg; Fiberite; Norsophen; Plaslok; Plenco; Polychem; Reliapreg; Resinoid; Texolite; Trolitan; Vyncolite

Typical uses

Electrical parts - sockets, switches, connectors, general industrial, water-lubricated bearings, relays, pump impellers, microwave cookware, handles, bottles tops, coatings, adhesives, bearings, foams and sandwich structures.

Composition overview

Compositional summary

PF + glass

Material family	Plastic (thermoset)		
Base material	PF (Phenol formaldehyde resin)		
% filler (by weight)	* 30	- 60	%
Filler/reinforcement	Glass		
Filler/reinforcement form	Short fiber (<5mm)		
Polymer code	PF-GF45		

Composition detail (polymers and natural materials)

Polymer	40	- 70	%
Glass (fiber)	* 30	- 60	%

Price

Price	* 1.2	- 1.64	USD/lb
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Physical properties

Density	0.0611	- 0.0723	lb/in^3
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Mechanical properties

Young's modulus	1.9	- 3.31	10^6 psi
Yield strength (elastic limit)	10.9	- 12	ksi
Tensile strength	8.7	- 17.4	ksi
Elongation	0.186	- 0.215	% strain
Compressive modulus	2.73	- 3.5	10^6 psi
Compressive strength	* 32.1	- 70.1	ksi
Flexural modulus	1.45	- 2.9	10^6 psi
Flexural strength (modulus of rupture)	14.5	- 26.1	ksi
Shear modulus	* 0.717	- 1.25	10^6 psi
Bulk modulus	* 2.33	- 2.45	10^6 psi
Poisson's ratio	0.31	- 0.34	
Shape factor	14		
Hardness - Vickers	* 22.5	- 24.9	HV
Hardness - Rockwell M	105	- 120	
Hardness - Rockwell R	* 122	- 134	
Fatigue strength at 10^7 cycles	* 3.48	- 6.96	ksi
Mechanical loss coefficient (tan delta)	* 0.00448	- 0.00661	

Impact & fracture properties

Fracture toughness	* 3.1	- 9.31	ksi.in^0.5
Impact strength, notched 23 °C	0.00159	- 0.0581	BTU/in^2

Thermal properties

Glass temperature	338	-	518	°F
Heat deflection temperature 0.45MPa	464	-	536	°F
Heat deflection temperature 1.8MPa	351	-	435	°F
Maximum service temperature	392	-	428	°F
Minimum service temperature	* -45.4	-	44.6	°F
Thermal conductivity	0.194	-	0.339	BTU.ft/hr.ft ² .°F
Specific heat capacity	* 0.272	-	0.283	BTU/lb.°F
Thermal expansion coefficient	8	-	34	μstrain/°F

Electrical properties

Electrical resistivity	3.3e18	-	3e19	μohm.cm
Dielectric constant (relative permittivity)	4.8	-	6.5	
Dissipation factor (dielectric loss tangent)	* 0.02	-	0.05	
Dielectric strength (dielectric breakdown)	140	-	399	V/mil
Comparative tracking index	125	-	225	V

Optical properties

Transparency	Opaque
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Magnetic properties

Magnetic type	Non-magnetic
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Bio-data

RoHS (EU) compliant grades?	✓
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Absorption & permeability

Water absorption @ 24 hrs	0.03	-	1.2	%
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Processing properties

Polymer injection molding	Acceptable			
Polymer extrusion	Unsuitable			
Polymer thermoforming	Unsuitable			
Linear mold shrinkage	0.1	-	0.4	%
Melt temperature	331	-	390	°F
Mold temperature	302	-	338	°F
Molding pressure range	0.998	-	20	ksi

Durability

Water (fresh)	Excellent
Water (salt)	Excellent
Weak acids	Excellent
Strong acids	Limited use
Weak alkalis	Unacceptable
Strong alkalis	Unacceptable
Organic solvents	Excellent
Oxidation at 500C	Unacceptable
UV radiation (sunlight)	Good
Flammability	Self-extinguishing

Primary production energy, CO2 and water

Embodied energy, primary production	* 2.45e4	-	2.7e4	BTU/lb
CO2 footprint, primary production	* 3.37	-	3.72	lb/lb
NOx creation	* 0.0126	-	0.0139	lb/lb

SOx creation	* 0.0377	-	0.0417	lb/lb
Water usage	* 4.26e3	-	4.71e3	in^3/lb

Processing energy, CO2 footprint & water

Polymer molding energy	* 6.2e3	-	6.85e3	BTU/lb
Polymer molding CO2	* 1.08	-	1.19	lb/lb
Polymer molding water	* 299	-	449	in^3/lb
Coarse machining energy (per unit wt removed)	* 930	-	1.03e3	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.162	-	0.179	lb/lb
Fine machining energy (per unit wt removed)	* 7.46e3	-	8.25e3	BTU/lb
Fine machining CO2 (per unit wt removed)	* 1.3	-	1.44	lb/lb
Grinding energy (per unit wt removed)	* 1.47e4	-	1.63e4	BTU/lb
Grinding CO2 (per unit wt removed)	* 2.57	-	2.84	lb/lb

Recycling and end of life

Recycle	✗			
Recycle fraction in current supply	0.1			%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 5.4e3	-	5.67e3	BTU/lb
Combustion CO2	* 1.14	-	1.2	lb/lb
Landfill	✓			
Biodegrade	✗			

Geo-economic data for principal component

Principal component	Phenol formaldehyde			
Annual world production	9.35e6	-	1.03e7	ton/yr
Reserves	2.34e8	-	2.59e8	l. ton

Links

ProcessUniverse

Producers

Reference

Shape