

General information

Designation

Phenol formaldehyde (Cellulose Filled, Impact Modified, 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 + cellulose filler

Material family	Plastic (thermoset)		
Base material	PF (Phenol formaldehyde resin)		
% filler (by weight)	* 30	- 55	%
Filler/reinforcement	Cellulose		
Filler/reinforcement form	Particulate		
Additive	Impact modifier		
Polymer code	PF-I-NX40		

Composition detail (polymers and natural materials)

Polymer	* 35	- 50	%
Impact modifier	10	- 20	%
Woodflour / cellulose	* 30	- 55	%

Price

Price	* 1.12	- 1.24	USD/lb
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Physical properties

Density	0.0499	- 0.0513	lb/in^3
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Mechanical properties

Young's modulus	* 0.898	- 1.3	10^6 psi
Yield strength (elastic limit)	5.08	- 5.8	ksi
Tensile strength	3.5	- 6.5	ksi
Elongation	1	- 2	% strain
Compressive modulus	* 0.898	- 1.3	10^6 psi
Compressive strength	* 22	- 31	ksi
Flexural modulus	0.898	- 1.3	10^6 psi
Flexural strength (modulus of rupture)	5.5	- 11	ksi
Shear modulus	* 0.334	- 0.482	10^6 psi
Bulk modulus	* 1.13	- 1.19	10^6 psi
Poisson's ratio	0.33	- 0.36	
Shape factor	13		
Hardness - Vickers	* 10.5	- 12	HV
Hardness - Rockwell M	105	- 115	
Hardness - Rockwell R	* 122	- 134	
Fatigue strength at 10^7 cycles	* 1.4	- 2.6	ksi
Mechanical loss coefficient (tan delta)	* 0.00863	- 0.0112	

Impact & fracture properties

Fracture toughness	* 1.13	- 2.38	ksi.in ^{0.5}
Impact strength, notched 23 °C	0.00128	- 0.00355	BTU/in ²
Impact strength, unnotched 23 °C	0.00377	- 0.00465	BTU/in ²

Thermal properties

Glass temperature	338	- 518	°F
Heat deflection temperature 0.45MPa	* 338	- 412	°F
Heat deflection temperature 1.8MPa	300	- 351	°F
Maximum service temperature	288	- 316	°F
Minimum service temperature	* -45.4	- 44.6	°F
Thermal conductivity	0.145	- 0.218	BTU.ft/hr.ft ² .°F
Specific heat capacity	* 0.329	- 0.342	BTU/lb.°F
Thermal expansion coefficient	20	- 34	μstrain/°F

Electrical properties

Electrical resistivity	3.3e15	- 3e16	μohm.cm
Dielectric constant (relative permittivity)	7.7	- 8.3	
Dissipation factor (dielectric loss tangent)	0.076	- 0.084	
Dielectric strength (dielectric breakdown)	300	- 381	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	0.5	- 0.9	%
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Processing properties

Polymer injection molding	Acceptable		
Polymer extrusion	Unsuitable		
Polymer thermoforming	Unsuitable		
Linear mold shrinkage	0.4	- 0.9	%
Melt temperature	331	- 399	°F
Mold temperature	302	- 338	°F
Molding pressure range	2	- 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	Slow-burning

Primary production energy, CO2 and water

Embodied energy, primary production	* 2.29e4	- 2.53e4	BTU/lb
CO2 footprint, primary production	* 2.96	- 3.27	lb/lb
NOx creation	* 0.0126	- 0.0139	lb/lb
SOx creation	* 0.0377	- 0.0417	lb/lb
Water usage	* 1.97e4	- 2.18e4	in^3/lb

Processing energy, CO2 footprint & water

Polymer molding energy	* 6.9e3	- 7.62e3	BTU/lb
Polymer molding CO2	* 1.2	- 1.33	lb/lb
Polymer molding water	* 318	- 477	in^3/lb
Coarse machining energy (per unit wt removed)	* 730	- 807	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.127	- 0.141	lb/lb
Fine machining energy (per unit wt removed)	* 5.47e3	- 6.04e3	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.954	- 1.05	lb/lb
Grinding energy (per unit wt removed)	* 1.07e4	- 1.19e4	BTU/lb
Grinding CO2 (per unit wt removed)	* 1.87	- 2.07	lb/lb

Recycling and end of life

Recycle	✗		
Recycle fraction in current supply	0.1		%
Downcycle	✓		
Combust for energy recovery	✓		
Heat of combustion (net)	* 1.01e4	- 1.06e4	BTU/lb
Combustion CO2	* 2.05	- 2.15	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

Notes

Warning

Attacked by alkalis

Links

ProcessUniverse

Producers

Reference

Shape