PLA (30% natural fiber)

General information

Designation

Polylactide / Polylactic acid (30% natural fiber filled)

Tradenames

Fibrolon (FKuR Kunststoff GmbH); Kareline (Kareline Oy Ltd.); Transmare Bio (Transmare Compounding

Typical uses

PLA reinforced with natural fibers is used for extruded profiles, diapers, pens, electronic cases, homeware, personal care products, medical devices and automotive parts. The current record is based on PLA filled with

Composition overview

Compositional summary

(CH(CH3)CO2)n + bamboo fiber. The lactic acid is produced from sugar (dextrose) with plant starch origins e.g. corn, wheat, sugar beets and sugar cane.

Material family	Plastic (thermoplastic, semi-crystalline)	
Base material	PLA (Polylactic acid / polylactide)	
% filler (by weight)	30	%
Filler/reinforcement	Cellulose	
Filler/reinforcement form	Short fiber	
Additive	Impact	
Renewable content	100	%
Polymer code	PLA-I-NX30	

Composition detail (polymers and natural materials)

Polymer		60	-	70	%
Impact modifier		0	-	10	%
Woodflour / cellulose		30			%

Price

Price	*	1.15	-	1.47	USD/lb
Price per unit volume	*	92.9	-	120	USD/ft^3

Physical properties

Density		0.0466	-	0.0473	lb/in^3

Mechanical properties

Young's modulus		0.753	-	0.772	10^6 psi
Yield strength (elastic limit)	*	10.5	-	11	ksi
Tensile strength		8.06	-	8.47	ksi
Elongation		1.45	-	1.56	% strain
Elongation at yield	*	0.737	-	0.794	% strain

Compressive modulus	* 0.753	-	0.772	10^6 psi
Compressive strength	12.6	-	13.2	ksi
Flexural modulus	0.68	-	0.698	10^6 psi
Flexural strength (modulus of rupture)	8.21	-	8.63	ksi
Shear modulus	* 0.273	-	0.276	10^6 psi
Poisson's ratio	* 0.38	-	0.4	
Shape factor	6.5			
Hardness - Vickers	* 18	-	19	HV
Hardness - Rockwell M	* 53	-	54	
Hardness - Rockwell R	* 35	-	36	
Hardness - Shore D	77	-	84	
Fatigue strength at 10^7 cycles	* 3.51	-	3.61	ksi
Mechanical loss coefficient (tan delta)	* 0.102	-	0.104	

Impact & fracture properties

Fracture toughness	* 3.65	-	3.88	ksi.in^0.5
Impact strength, notched 23 °C	0.00116	-	0.00128	BTU/in^2
Impact strength, unnotched 23 °C	0.00495	-	0.00546	BTU/in^2

Thermal properties

Melting point	293	-	347	°F
Glass temperature	126	-	129	°F
Heat deflection temperature 0.45MPa	124	-	127	°F
Heat deflection temperature 1.8MPa	127	-	131	°F
Vicat softening point	144	-	153	°F
Maximum service temperature	* 113	-	131	°F
Minimum service temperature	-4	-	10.4	°F
Thermal conductivity	* 0.0844	-	0.0884	BTU.ft/hr.ft^2.°F
Specific heat capacity	* 0.301	-	0.318	BTU/lb.°F
Thermal expansion coefficient	* 58.9	-	62.2	µstrain/°F

Electrical properties

Electrical resistivity	* 9.84e16	-	1.89e17	µohm.in
Dielectric constant (relative permittivity)	* 4.38	-	4.56	
Dissipation factor (dielectric loss tangent)	* 0.0963	-	0.117	
Dielectric strength (dielectric breakdown)	* 335	-	348	V/mil

Magnetic properties

Magnetic type	Non-magnetic

Optical properties

Refractive index	*	1.44	-	1.46	
Transparency		Opaque			

Critical materials risk

Contains >5wt% critical elements?		No			

Absorption & permeability

Water absorption @ 24 hrs		0.7	-	1.1	%
Water absorption @ sat	*	1	-	1.8	%
Humidity absorption @ sat	*	0.3	-	0.55	%
Water vapor transmission		5.73e-5	-	7.34e-5	lb.in/ft^2.day
Permeability (O2)		1.18e-7	-	5.7e-7	ft^2/day.atm

Processing properties

Polymer injection molding		Acceptable			
Polymer extrusion		Limited use			
Polymer thermoforming		Limited use			
Linear mold shrinkage		0.16	-	0.4	%
Melt temperature		302	-	410	°F
Mold temperature		41	-	95	°F
Molding pressure range		7.98	-	14.5	ksi

Durability

Water (fresh)		Acceptable			
Water (salt)		Acceptable			
Weak acids		Acceptable			
Strong acids		Unacceptable			
Weak alkalis		Acceptable			
Strong alkalis		Unacceptable			
Organic solvents		Limited use			
UV radiation (sunlight)		Good			
Flammability		Highly flammable			

Primary production energy, CO2 and water

Embodied energy, primary production	*	1.91e4	-	2.1e4	BTU/lb
CO2 footprint, primary production	*	2.36	-	2.6	lb/lb
Water usage	*	3.72e4	-	5.88e4	in^3/lb

Processing energy, CO2 footprint & water

Polymer extrusion energy	*	2.5e3	-	2.63e3	BTU/lb
Polymer extrusion CO2	*	0.436	-	0.458	lb/lb
Polymer extrusion water					

	* 132	-	198	in^3/lb
Polymer molding energy	* 6.23e3	-	6.53e3	BTU/lb
Polymer molding CO2	* 1.09	-	1.14	lb/lb
Polymer molding water	* 296	-	443	in^3/lb
Coarse machining energy (per unit wt removed)	228	-	239	BTU/lb
Coarse machining CO2 (per unit wt removed)	0.0398	-	0.0418	lb/lb
Fine machining energy (per unit wt removed)	394	-	413	BTU/lb
Fine machining CO2 (per unit wt removed)	0.0686	-	0.0721	lb/lb
Grinding energy (per unit wt removed)	576	-	606	BTU/lb
Grinding CO2 (per unit wt removed)	0.101	-	0.106	lb/lb

Recycling and end of life

Recycle	✔			
Embodied energy, recycling	* 6.49e3	-	7.14e3	BTU/lb
CO2 footprint, recycling	* 0.8	-	0.884	lb/lb
Recycle fraction in current supply	0.1	-	1.1	%
Downcycle	✔			
Combust for energy recovery	✔			
Heat of combustion (net)	* 6.49e3	-	7.52e3	BTU/lb
Combustion CO2	* 1.37	-	1.44	lb/lb
Landfill	✔			
Biodegrade	✔			

Notes

Other notes

PLA is a renewable thermoplastic polyester manufactured from plants such as sugarcane, corn and tapioca. PLA can be amorphous or semi-crystalline. Various blends of D and L enantiomers are available, making available a broader range of properties. PLA products are considered environmentally friendly as their production uses approximately 50% less energy and produces 60% less CO2 than petroleum based products e.g. PET, PC, PS and nylon. Natural fibers that can be used as a filler include coir, cotton, flax, hemp, jute, kenaf, ramie, silk, sisal, bamboo, abaca and wool.

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