

General information

Designation

Fraxinus americana (T)

Typical uses

handles; oars; vehicle parts; baseball bats & other sporting & athletic

Composition overview

Cellulose/Hemicellulose/Lignin/12%H2O

Compositional summary

Material family	Natural	
Base material	Wood (hardwood)	
Renewable content	100	%

Composition detail (polymers and natural materials)

Wood	100	%
Price		

Price

Price	* 2.01	- 2.68	USD/kg	
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Physical properties

Density	600	-	740	kg/m^3	
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Mechanical properties

Mechanical properties				
Young's modulus	* 1.82	-	2.03	GPa
Yield strength (elastic limit)	* 3.48	-	4.26	MPa
Tensile strength	5.8	-	7.1	MPa
Elongation	* 0.94	-	1.15	% strain
Compressive strength	7.2	-	8.8	MPa
Flexural modulus	1.65	-	1.85	GPa
Flexural strength (modulus of rupture)	* 5.8	-	7.1	MPa
Shear modulus	* 0.188	-	0.258	GPa
Shear strength	* 35.6	-	43.6	MPa
Rolling shear strength	* 1.32	-	3.97	MPa
Bulk modulus	* 0.93	-	1.04	GPa
Poisson's ratio	* 0.02	-	0.04	
Shape factor	5.6			
Hardness - Vickers	5.28	-	6.46	HV
Hardness - Brinell	* 24.5	-	30	MPa
Hardness - Janka	5.28	-	6.46	kN
Fatigue strength at 10^7 cycles	* 1.74	-	2.13	MPa



Flammability

Ash (fraxinus americana) (t)

Differential shrinkage (radial) * 0.17 - 0.2 % Differential shrinkage (tangential) * 0.28 - 0.34 % Radial shrinkage (green to oven-dry) 4.4 - 5.4 % Tangential shrinkage (green to oven-dry) 7 - 8.6 % Volumetric shrinkage (green to oven-dry) 12 - 14.6 % Work to maximum strength * 10.3 - 12.6 kJ/m^3	i EDUPACK				
Differential shrinkage (tangential), 0.28 0.34 %	Mechanical loss coefficient (tan delta)	* 0.018	-	0.022	
Radial shrinkage (green to oven-dry)	Differential shrinkage (radial)	* 0.17	-	0.2	%
Tangential shrinkage (green to oven-dry)	Differential shrinkage (tangential)	* 0.28	-	0.34	%
Volumetric shrinkage (green to oven-dry)	Radial shrinkage (green to oven-dry)	4.4	-	5.4	%
March to maximum strength	Tangential shrinkage (green to oven-dry)	7	-	8.6	%
	Volumetric shrinkage (green to oven-dry)	12	-	14.6	%
**0.496 - 0.606 MPa.m*0.5	Work to maximum strength	* 10.3	-	12.6	kJ/m^3
**0.496 - 0.606 MPa.m*0.5	Impact & fracture properties				
Salas temperature	Fracture toughness	* 0.496	-	0.606	MPa.m^0.5
Salas temperature	Thermal properties				
Minimum service temperature * -73		77	-	102	°C
Thermal conductivity 0.13 - 0.17 W/m.°C Specific heat capacity 1.66e3 - 1.71e3 J/kg.°C Thermal expansion coefficient *30.6 - 41.2 µstrain/°C Electrical properties Electrical resistivity *8.54e13 - 1.28e14 µohm.cm Dielectric constant (relative permittivity) *3.77 - 4.61 Dissipation factor (dielectric loss tangent) *0.052 - 0.063 Dielectric strength (dielectric breakdown) *1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Weak acids Limited use Weak acids Limited use Strong acids Unacceptable Weak alkalis Acceptable Organic solvents Oxidation at 500C Unacceptable Oxidation at 500C	Maximum service temperature	120	-	140	°C
Specific heat capacity 1.66e3 - 1.71e3 J/kg.°C Thermal expansion coefficient * 30.6 - 41.2 µstrain/°C Electrical properties Electrical resistivity * 8.54e13 - 1.28e14 µohm.cm Dielectric constant (relative permittivity) * 3.77 - 4.61 Dissipation factor (dielectric loss tangent) Dielectric strength (dielectric breakdown) * 1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Opaque Opaque Durability Water (fresh) Limited use Water (salt) Limited use Weak acids Strong acids Unacceptable Weak alkalis Strong alkalis Organic solvents Oxidation at 500C Unacceptable Oxidation at 500C	•	* -73	-	-23	°C
Thermal expansion coefficient * 30.6 - 41.2 µstrain/°C Electrical properties Electrical resistivity * 8.54e13 - 1.28e14 µohm.cm Dielectric constant (relative permittivity) * 3.77 - 4.61 Dissipation factor (dielectric loss tangent) * 0.052 - 0.063 Dielectric strength (dielectric breakdown) * 1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Water (salt) Limited use Weak acids Limited use Strong acids Unacceptable Weak alkalis Acceptable Organic solvents Oxidation at 500C Unacceptable Oxidation at 500C	Thermal conductivity	0.13	-	0.17	W/m.°C
Electrical properties Electrical resistivity * 8.54e13 - 1.28e14 µohm.cm Dielectric constant (relative permittivity) * 3.77 - 4.61 Dissipation factor (dielectric loss tangent) * 0.052 - 0.063 Dielectric strength (dielectric breakdown) * 1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Water (salt) Limited use Weak acids Limited use Strong acids Unacceptable Weak alkalis Acceptable Organic solvents Oxidation at 500C Unacceptable Oxidation at 500C Unacceptable Oxidation at 500C	Specific heat capacity	1.66e3	-	1.71e3	J/kg.°C
Electrical resistivity	Thermal expansion coefficient	* 30.6	-	41.2	μstrain/°C
Electrical resistivity	Flectrical properties				
Dielectric constant (relative permittivity) * 3.77 - 4.61 Dissipation factor (dielectric loss tangent) * 0.052 - 0.063 Dielectric strength (dielectric breakdown) * 1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Water (salt) Limited use Weak acids Limited use Strong acids Unacceptable Weak alkalis Acceptable Organic solvents Oxidation at 500C Unacceptable Unacceptable Oxidation at 500C		* 8.54e13	-	1.28e14	µohm.cm
Dissipation factor (dielectric loss tangent) * 0.052 - 0.063 Dielectric strength (dielectric breakdown) * 1 - 2 MV/m * Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Water (salt) Limited use Unacceptable Strong acids Unacceptable Organic solvents Oxidation at 500C Unacceptable Oxidation at 500C	•	* 3.77	-	4.61	•
Dielectric strength (dielectric breakdown) * 1 - 2 MV/m Magnetic properties Magnetic type Non-magnetic Optical properties Transparency Opaque Durability Water (fresh) Limited use Water (salt) Limited use Weak acids Limited use Strong acids Unacceptable Weak alkalis Strong alkalis Organic solvents Oxidation at 500C MV/m MV/m MV/m Av/m MV/m Av/m MV/m Av/m MV/m Av/m Av/m MV/m Av/m Av/m MV/m Av/m Av/m Av/m Av/m Av/m MV/m Av/m Av/m Av/m Av/m Av/m Av/m Av/m Av/m MV/m Av/m	· · · · · · · · · · · · · · · · · · ·	* 0.052	-	0.063	
Magnetic type Optical properties Transparency Opaque Durability Water (fresh) Water (salt) Weak acids Strong acids Unacceptable Strong alkalis Organic solvents Opaque Non-magnetic Non-	• •	* 1	-	2	MV/m
Magnetic type Optical properties Transparency Opaque Durability Water (fresh) Water (salt) Weak acids Strong acids Unacceptable Strong alkalis Organic solvents Opaque Non-magnetic Non-	Magnetic properties				
Optical properties Transparency Opaque Durability Water (fresh) Water (salt) Weak acids Unacceptable Weak alkalis Strong alkalis Organic solvents Opaque Upaque Upa		Non-mag	notic		
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Strong acids Weak alkalis Acceptable Strong alkalis Unacceptable Unacceptable Organic solvents Acceptable Oxidation at 500C Unacceptable	Water (salt)	Limited u	se		
Weak alkalis Strong alkalis Unacceptable Organic solvents Oxidation at 500C Acceptable Unacceptable Unacceptable	Weak acids	Limited u	se		
Strong alkalis Unacceptable Organic solvents Acceptable Oxidation at 500C Unacceptable	Strong acids	Unaccept	able)	
Organic solvents Acceptable Unacceptable	Weak alkalis	Acceptab	le		
Organic solvents Acceptable Unacceptable	Strong alkalis			;	
Oxidation at 500C Unacceptable	-	·			
·)	
	UV radiation (sunlight)	·			



Reference Shape

	Highly	flamm	able	
Primary production energy, CO2 and water				
Embodied energy, primary production	11.6	-	12.8	MJ/kg
Sources 0.5 MJ/kg (Ximenes, 2006); 2 MJ/kg (Ximenes, 2006); 9.1 MJ/kg (Hammond a MJ/kg (Ecoinvent v2.2); 26 MJ/kg (Ecoinvent v2.2)	and Jones, 2008	B); 11.6 N	/J/kg (Hubba	rd and Bowe, 2010); 23.7
CO2 footprint, primary production	0.574	-	0.633	kg/kg
Sources 0.229 kg/kg (Ecoinvent v2.2); 0.412 kg/kg (Ecoinvent v2.2); 0.862 kg/kg (Han	nmond and Jon	es, 2008); 0.909 kg/k	g (Hubbard and Bowe,
Vater usage	* 665	-	735	l/kg
Processing energy, CO2 footprint & water				
Coarse machining energy (per unit wt removed)	* 0.588	-	0.65	MJ/kg
Coarse machining CO2 (per unit wt removed)	* 0.044	-	0.0488	kg/kg
Fine machining energy (per unit wt removed)	* 1.61	-	1.78	MJ/kg
Fine machining CO2 (per unit wt removed)	* 0.121	-	0.133	kg/kg
Grinding energy (per unit wt removed)	* 2.74	-	3.03	MJ/kg
Grinding CO2 (per unit wt removed)	* 0.206	-	0.228	kg/kg
Recycling and end of life				
Recycle	×			
Recycle fraction in current supply	8.55	-	9.45	%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 19.8	-	21.3	MJ/kg
Combustion CO2	* 1.69	-	1.78	kg/kg
_andfill	✓			
-anum				