

## General information

### Designation

Fraxinus americana

### Typical uses

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

## Composition overview

### Compositional summary

Cellulose/Hemicellulose/Lignin/12%H2O

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

### Composition detail (polymers and natural materials)

Wood	100 %
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### Price

Price	* 0.912	-	1.22	USD/lb
Price per unit volume	* 34.3	-	56.1	USD/ft^3

### Physical properties

Density	0.0217	-	0.0267	lb/in^3
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### Mechanical properties

Young's modulus	* 0.264	-	0.294	10^6 psi
Yield strength (elastic limit)	* 0.505	-	0.618	ksi
Tensile strength	0.841	-	1.03	ksi
Elongation	* 0.94	-	1.15	% strain
Compressive strength	1.04	-	1.28	ksi
Flexural modulus	0.239	-	0.268	10^6 psi
Flexural strength (modulus of rupture)	* 0.841	-	1.03	ksi
Shear modulus	* 0.0273	-	0.0374	10^6 psi
Shear strength	* 5.16	-	6.33	ksi
Rolling shear strength	* 0.191	-	0.576	ksi
Bulk modulus	* 0.135	-	0.151	10^6 psi
Poisson's ratio	* 0.02	-	0.04	
Shape factor	5.6			
Hardness - Vickers	5.28	-	6.46	HV
Hardness - Brinell	* 24.5	-	30	HB
Hardness - Janka	1.19e3	-	1.45e3	lbf

Fatigue strength at 10 <sup>7</sup> cycles	* 0.252	-	0.309	ksi
Mechanical loss coefficient (tan delta)	* 0.018	-	0.022	
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	* 0.124	-	0.152	ft.lbf/in <sup>3</sup>

### Impact & fracture properties

Fracture toughness	* 0.451	-	0.551	ksi.in <sup>0.5</sup>
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### Thermal properties

Glass temperature	171	-	216	°F
Maximum service temperature	248	-	284	°F
Minimum service temperature	* -99.4	-	-9.4	°F
Thermal conductivity	0.0751	-	0.0982	BTU.ft/hr.ft <sup>2</sup> .°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 17	-	22.9	µstrain/°F

### Electrical properties

Electrical resistivity	* 3.36e13	-	5.04e13	µohm.in
Dielectric constant (relative permittivity)	* 3.77	-	4.61	
Dissipation factor (dielectric loss tangent)	* 0.052	-	0.063	
Dielectric strength (dielectric breakdown)	* 25.4	-	50.8	V/mil

### Magnetic properties

Magnetic type	Non-magnetic
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### Optical properties

Transparency	Opaque
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### Critical materials risk

Contains >5wt% critical elements?	No
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### Durability

Water (fresh)	Limited use
Water (salt)	Limited use
Weak acids	Limited use
Strong acids	Unacceptable
Weak alkalis	Acceptable
Strong alkalis	Unacceptable

Organic solvents	Acceptable
Oxidation at 500C	Unacceptable
UV radiation (sunlight)	Good
Flammability	Highly flammable

### Primary production energy, CO2 and water

Embodied energy, primary production	4.99e3	-	5.5e3	BTU/lb
Sources 0.5 MJ/kg (Ximenes, 2006); 2 MJ/kg (Ximenes, 2006); 9.1 MJ/kg (Hammond and Jones, 2008); 11.6 MJ/kg (Hubbard and Bowe, 2010); 23.7 MJ/kg (Ecoinvent v2.2); 26 MJ/kg (Ecoinvent v2.2)				
CO2 footprint, primary production	0.574	-	0.633	lb/lb
Sources 0.229 kg/kg (Ecoinvent v2.2); 0.412 kg/kg (Ecoinvent v2.2); 0.862 kg/kg (Hammond and Jones, 2008); 0.909 kg/kg (Hubbard and Bowe, 2010)				
Water usage	* 1.84e4	-	2.03e4	in^3/lb

### Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 253	-	280	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0441	-	0.0488	lb/lb
Fine machining energy (per unit wt removed)	* 692	-	765	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.121	-	0.133	lb/lb
Grinding energy (per unit wt removed)	* 1.18e3	-	1.3e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.206	-	0.228	lb/lb

### Recycling and end of life

Recycle	✗			
Recycle fraction in current supply	8.55	-	9.45	%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 8.49e3	-	9.16e3	BTU/lb
Combustion CO2	* 1.69	-	1.78	lb/lb
Landfill	✓			
Biodegrade	✓			

### Notes

#### Warning

All woods have properties which show variation; they depend principally on growth conditions and moisture

### Links

ProcessUniverse

Reference

Shape

