

## General information

### Designation

Betula alleghaniensis

### Typical uses

Furniture; boxes; baskets; crates; woodenware; cooperage; interior finish; doors. As veneer in plywood: flush doors; furniture; paneling; radio & television cabinets; aircraft.

## 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	* 0.304	-	0.608	USD/lb
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## Physical properties

Density	0.0224	-	0.0275	lb/in^3
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## Mechanical properties

Young's modulus	* 0.292	-	0.325	10^6 psi
Yield strength (elastic limit)	* 0.496	-	0.609	ksi
Tensile strength	0.827	-	1.02	ksi
Elongation	* 0.84	-	1.03	% strain
Compressive strength	0.873	-	1.07	ksi
Flexural modulus	0.265	-	0.296	10^6 psi
Flexural strength (modulus of rupture)	* 0.827	-	1.02	ksi
Shear modulus	* 0.0302	-	0.0413	10^6 psi
Shear strength	* 5.09	-	6.22	ksi
Rolling shear strength	* 0.189	-	0.566	ksi
Bulk modulus	* 0.149	-	0.167	10^6 psi
Poisson's ratio	* 0.02	-	0.04	
Shape factor	5.6			
Hardness - Vickers	5.04	-	6.17	HV
Hardness - Brinell	* 3.96	-	4.83	ksi
Hardness - Janka	1.13e3	-	1.39e3	lbf

Fatigue strength at 10 <sup>7</sup> cycles	* 0.248	-	0.305	ksi
Mechanical loss coefficient (tan delta)	* 0.017	-	0.021	
Differential shrinkage (radial)	0.18	-	0.24	%
Differential shrinkage (tangential)	0.26	-	0.31	%
Radial shrinkage (green to oven-dry)	6.6	-	8	%
Tangential shrinkage (green to oven-dry)	8.6	-	10.5	%
Volumetric shrinkage (green to oven-dry)	15.1	-	18.5	%
Work to maximum strength	* 0.156	-	0.191	ft.lbf/in <sup>3</sup>

### Impact & fracture properties

Fracture toughness	* 0.474	-	0.58	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	0.0693	-	0.0809	BTU.ft/hr.ft <sup>2</sup> .°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 17.3	-	23.2	µstrain/°F

### Electrical properties

Electrical resistivity	* 8.73e14	-	1.3e15	µohm.cm
Dielectric constant (relative permittivity)	* 3.87	-	4.74	
Dissipation factor (dielectric loss tangent)	* 0.054	-	0.065	
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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### Bio-data

Food contact	Yes
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### Restricted substances risk indicators

RoHS (EU) compliant grades?	✓
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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)				
NOx creation	0.00257	-	0.00284	lb/lb
SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

### Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 244	-	269	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0425	-	0.047	lb/lb
Fine machining energy (per unit wt removed)	* 600	-	663	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.105	-	0.116	lb/lb
Grinding energy (per unit wt removed)	* 996	-	1.1e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.174	-	0.192	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	✓			

### Eco-indicators for principal component

Eco-indicator 95	2.99			millipoints/lb
EPS value	62.7	-	69.3	

### Notes

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**Warning**

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

**Links**

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[ProcessUniverse](#)

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[Reference](#)

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[Shape](#)

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## General information

### Designation

Betula lenta

### Typical uses

Furniture; boxes; baskets; crates; woodenware; cooperage; interior finish; doors. As veneer in plywood: flush doors; furniture; paneling; radio & television cabinets; aircraft.

## 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	* 0.304 - 0.608 USD/lb
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### Physical properties

Density	0.0238 - 0.0289 lb/in^3
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### Mechanical properties

Young's modulus	* 0.335 - 0.376 10^6 psi
Yield strength (elastic limit)	* 0.513 - 0.627 ksi
Tensile strength	0.856 - 1.04 ksi
Elongation	* 0.75 - 0.92 % strain
Compressive strength	0.972 - 1.19 ksi
Flexural modulus	0.305 - 0.341 10^6 psi
Flexural strength (modulus of rupture)	* 0.856 - 1.04 ksi
Shear modulus	* 0.0347 - 0.0479 10^6 psi
Shear strength	* 6.05 - 7.39 ksi
Rolling shear strength	* 0.223 - 0.672 ksi
Bulk modulus	* 0.171 - 0.191 10^6 psi
Poisson's ratio	* 0.02 - 0.04
Shape factor	5.6
Hardness - Vickers	5.88 - 7.19 HV
Hardness - Brinell	* 4.21 - 5.13 ksi
Hardness - Janka	1.32e3 - 1.62e3 lbf

Fatigue strength at 10 <sup>7</sup> cycles	* 0.257	-	0.313	ksi
Mechanical loss coefficient (tan delta)	* 0.016	-	0.02	
Differential shrinkage (radial)	0.18	-	0.24	%
Differential shrinkage (tangential)	0.26	-	0.31	%
Radial shrinkage (green to oven-dry)	5.9	-	7.2	%
Tangential shrinkage (green to oven-dry)	8.1	-	9.9	%
Volumetric shrinkage (green to oven-dry)	14	-	17.2	%
Work to maximum strength	* 0.135	-	0.166	ft.lbf/in <sup>3</sup>

### Impact & fracture properties

Fracture toughness	* 0.509	-	0.622	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	* 0.0664	-	0.0815	BTU.ft/hr.ft <sup>2</sup> .°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 17.8	-	23.8	µstrain/°F

### Electrical properties

Electrical resistivity	* 2.1e14	-	7e14	µohm.cm
Dielectric constant (relative permittivity)	* 4.03	-	4.92	
Dissipation factor (dielectric loss tangent)	* 0.056	-	0.069	
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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### Bio-data

Food contact	Yes
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### Restricted substances risk indicators

RoHS (EU) compliant grades?	✓
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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)				
NOx creation	0.00257	-	0.00284	lb/lb
SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

### Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 246	-	272	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0429	-	0.0474	lb/lb
Fine machining energy (per unit wt removed)	* 621	-	686	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.108	-	0.12	lb/lb
Grinding energy (per unit wt removed)	* 1.04e3	-	1.15e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.181	-	0.2	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	✓			

### Eco-indicators for principal component

Eco-indicator 95	2.99			millipoints/lb
EPS value	62.7	-	69.3	

### Notes

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**Warning**

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

**Links**

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[ProcessUniverse](#)

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[Reference](#)

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[Shape](#)

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## General information

### Designation

Betula papyrifera

### Typical uses

Turned products including spools; bobbins; small handles & toys.

## Composition overview

### Compositional summary

Cellulose/Hemicellulose/Lignin/12%H<sub>2</sub>O

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

### Composition detail (polymers and natural materials)

Wood	100		%
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### Price

Price	* 0.304	-	0.608	USD/lb
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### Physical properties

Density	0.0199	-	0.0246	lb/in <sup>3</sup>
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### Mechanical properties

Young's modulus	* 0.203	-	0.228	10 <sup>6</sup> psi
Yield strength (elastic limit)	* 0.537	-	0.667	ksi
Tensile strength	* 0.551	-	0.682	ksi
Elongation	* 0.81	-	0.99	% strain
Compressive strength	0.54	-	0.66	ksi
Flexural modulus	0.184	-	0.207	10 <sup>6</sup> psi
Flexural strength (modulus of rupture)	* 0.551	-	0.682	ksi
Shear modulus	* 0.021	-	0.029	10 <sup>6</sup> psi
Shear strength	* 3.27	-	3.99	ksi
Rolling shear strength	* 0.12	-	0.363	ksi
Bulk modulus	* 0.104	-	0.117	10 <sup>6</sup> psi
Poisson's ratio	* 0.02	-	0.04	
Shape factor	5.5			
Hardness - Vickers	3.64	-	4.45	HV
Hardness - Brinell	* 2.68	-	3.26	ksi
Hardness - Janka	818	-	1e3	lbf
Fatigue strength at 10 <sup>7</sup> cycles	* 0.165	-	0.205	ksi

Mechanical loss coefficient (tan delta)	* 0.02	-	0.026	
Differential shrinkage (radial)	0.18	-	0.24	%
Differential shrinkage (tangential)	0.26	-	0.31	%
Radial shrinkage (green to oven-dry)	5.7	-	6.9	%
Tangential shrinkage (green to oven-dry)	7.7	-	9.5	%
Volumetric shrinkage (green to oven-dry)	14.6	-	17.8	%
Work to maximum strength	* 0.12	-	0.146	ft.lbf/in^3

### Impact & fracture properties

Fracture toughness	0.462	-	0.564	ksi.in^0.5
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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	0.0693	-	0.0809	BTU.ft/hr.ft^2.°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 16.2	-	21.9	µstrain/°F

### Electrical properties

Electrical resistivity	* 2.1e14	-	7e14	µohm.cm
Dielectric constant (relative permittivity)	* 3.52	-	4.3	
Dissipation factor (dielectric loss tangent)	* 0.047	-	0.058	
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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### Bio-data

Food contact	Yes
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### Restricted substances risk indicators

RoHS (EU) compliant grades?	✓
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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)				
NOx creation	0.00257	-	0.00284	lb/lb
SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

### Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 232	-	256	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0404	-	0.0447	lb/lb
Fine machining energy (per unit wt removed)	* 479	-	529	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.0836	-	0.0924	lb/lb
Grinding energy (per unit wt removed)	* 754	-	833	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.131	-	0.145	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	✓			

### Eco-indicators for principal component

Eco-indicator 95	2.99			millipoints/lb
EPS value	62.7	-	69.3	

### Notes

#### Warning

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

### Links

ProcessUniverse

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Shape

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## General information

### Designation

Betula verrucosa

### Typical uses

Furniture; fittings; turnery; carvings; plywood; brush backs; broom heads.

## Composition overview

### Compositional summary

Cellulose/Hemicellulose/Lignin/12%H<sub>2</sub>O

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

### Composition detail (polymers and natural materials)

Wood	100		%
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### Price

Price	* 0.304	-	0.608	USD/lb
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### Physical properties

Density	0.0224	-	0.0275	lb/in <sup>3</sup>
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### Mechanical properties

Young's modulus	0.115	-	0.141	10 <sup>6</sup> psi
Yield strength (elastic limit)	* 0.54	-	0.661	ksi
Tensile strength	0.899	-	1.1	ksi
Elongation	* 2.12	-	2.59	% strain
Compressive strength	1.41	-	1.72	ksi
Flexural modulus	0.104	-	0.128	10 <sup>6</sup> psi
Flexural strength (modulus of rupture)	* 0.899	-	1.1	ksi
Shear modulus	* 0.0119	-	0.0178	10 <sup>6</sup> psi
Shear strength	* 5.09	-	6.22	ksi
Rolling shear strength	* 0.189	-	0.566	ksi
Bulk modulus	* 0.0595	-	0.0725	10 <sup>6</sup> psi
Poisson's ratio	* 0.02	-	0.04	
Shape factor	5.1			
Hardness - Vickers	* 5.08	-	6.21	HV
Hardness - Brinell	3.79	-	4.63	ksi
Hardness - Janka	* 1.14e3	-	1.4e3	lbf
Fatigue strength at 10 <sup>7</sup> cycles	* 0.27	-	0.331	ksi

Mechanical loss coefficient (tan delta)	* 0.027	-	0.033	
Differential shrinkage (radial)	0.18	-	0.24	%
Differential shrinkage (tangential)	0.26	-	0.31	%
Radial shrinkage (green to oven-dry)	4.8	-	5.8	%
Tangential shrinkage (green to oven-dry)	7	-	8.6	%
Volumetric shrinkage (green to oven-dry)	12.6	-	15.3	%
Work to maximum strength	* 0.109	-	0.133	ft.lbf/in^3

### Impact & fracture properties

Fracture toughness	0.413	-	0.504	ksi.in^0.5
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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	* 0.0624	-	0.0763	BTU.ft/hr.ft^2.°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 17.3	-	23.2	µstrain/°F

### Electrical properties

Electrical resistivity	* 2.1e14	-	7e14	µohm.cm
Dielectric constant (relative permittivity)	* 3.85	-	4.71	
Dissipation factor (dielectric loss tangent)	* 0.053	-	0.065	
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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### Bio-data

Food contact	Yes
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### Restricted substances risk indicators

RoHS (EU) compliant grades?	✓
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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)				
NOx creation	0.00257	-	0.00284	lb/lb
SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

### Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 268	-	296	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0468	-	0.0517	lb/lb
Fine machining energy (per unit wt removed)	* 844	-	933	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.147	-	0.163	lb/lb
Grinding energy (per unit wt removed)	* 1.48e3	-	1.64e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.259	-	0.286	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	✓			

### Eco-indicators for principal component

Eco-indicator 95	2.99			millipoints/lb
EPS value	62.7	-	69.3	

### Notes

#### Warning

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

## Links

ProcessUniverse

Reference

Shape

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