

Description

Image



Caption

1. Leather hat. 2. Leather armchair. © John Fernandez

The material

Leather is a natural fabric. It is made by the tanning of animal hide, a smelly process in which the hide is soaked in solutions of tannins for weeks or months, making it pliable and resistant to decay. It has high tensile strength and is exceptionally tough and resilient, yet it is flexible and - as suede - is soft to touch. Leather is used for belts, gaskets, shoes, jackets, handbags, linings and coverings. It can be injection molded by placing a piece in the mold prior to injected the polymer resin.

Composition (summary)

Collagen (protein)/12% H₂O

General properties

Density	50.6	-	65.5	lb/ft ³
Price	* 7.53	-	9.39	USD/lb
Date first used	-10000			

Mechanical properties

Young's modulus	0.0145	-	0.0725	10 ⁶ psi
Shear modulus	* 0.00435	-	0.0145	10 ⁶ psi
Bulk modulus	* 0.145	-	0.29	10 ⁶ psi
Poisson's ratio	0.05	-	0.48	
Yield strength (elastic limit)	0.725	-	1.45	ksi
Tensile strength	2.9	-	3.77	ksi
Compressive strength	0.145	-	0.29	ksi
Elongation	18	-	75	% strain
Hardness - Vickers	* 2	-	3	HV
Fatigue strength at 10 ⁷ cycles	0.653	-	1.31	ksi
Fracture toughness	* 2.73	-	4.55	ksi.in ^{0.5}
Mechanical loss coefficient (tan delta)	* 0.1	-	0.5	

Thermal properties

Glass temperature	* 224	-	260	°F
Maximum service temperature	* 224	-	260	°F
Minimum service temperature	* -118	-	-99.7	°F
Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.0901	-	0.0924	BTU.ft/h.ft ² .F
Specific heat capacity	0.366	-	0.413	BTU/lb.°F

Thermal expansion coefficient	* 22.2	-	27.8	μstrain/°F
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Electrical properties

Electrical conductor or insulator?

Poor insulator

Electrical resistivity

* 1e8	-	1e10	μohm.cm
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Dielectric constant (relative permittivity)

* 5	-	10
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Dissipation factor (dielectric loss tangent)

* 0.01	-	0.05
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Dielectric strength (dielectric breakdown)

* 12.7	-	25.4	V/mil
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Optical properties

Transparency

Opaque

Processability

Moldability

3	-	4
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Machinability

4

Eco properties

Embodied energy, primary production

1.11e4	-	1.22e4	kcal/lb
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CO2 footprint, primary production

4.08	-	4.5	lb/lb
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Recycle

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Supporting information

Design guidelines

The quality of leather depends on the animal. Most comes from cattle, but some also from sheep, goat, deer, alligator, seal, shark and even snake. 'Top grade' leather is the outside layer, and is the best quality: durable, close fibers, with the highest strength and flexibility. 'First split' leather comes from the next layer; it has lower quality. 'Second split', from the inside, has the lowest quality. 'Patent leather' is an old name for glossy black leather for shoes and handbags.

Technical notes

Leather for drive belts (and those that hold up trousers) is soaked in oils or waxes to make it flexible; it has a density of 0.95 Mg/m³ and a tensile strength up to 26 MPa. Leather is remarkable for having a tensile stiffness and strength that is much greater than that in bending, allowing it to flex easily yet carry tensile loads. It is a consequence of the fibrous nature of the material: the fibers all lie in the plane of the skin.

Typical uses

Drive belts and seals; shoes; bags; jackets, cases and luggage; briefcases hats, clothing; fancy goods, handbags and linings.

Links

Reference

ProcessUniverse