Description

Image



Caption

1. Close-up of the material. © John Fernandez 2. Cork, used to make wine bottle stoppers (corks). © Chris Lefteri
3. Cork is the bark of the cork oak, Quercus Suber. © Granta Design

The material

Cork is a natural closed-cell foam, and is waterproof and remarkably stable, surviving in the neck of a wine bottle for 50 years or more without decay or contaminating the wine. Corkboard, made by compressing granulated cork under heat, is used for wall and ceiling insulation. Cork itself has a remarkable combination of properties. It is light yet resilient, insulates against heat and sound, has a high coefficient of friction, is imperious to liquids, chemically stable and fire resistant. Demand for cork exceeds 500,000 tones per year - and one tonne of cork has the same volume as 56 tonnes of steel.

Composition (summary)

40% Suberin / 27% Lignin / 12% Cellulose / 4% Friedelin / 17% Water

General properties

Density		7.49	-	15	lb/ft^3
Price	*	1.22	-	6.08	USD/lb
Date first used		-3000			

Mechanical properties

Young's modulus		0.00189	-	0.00725	10^6 psi
Shear modulus		3.63e-4	-	0.00116	10^6 psi
Bulk modulus		0.00145	-	0.00261	10^6 psi
Poisson's ratio		0.05	-	0.45	
Yield strength (elastic limit)	*	0.0435	-	0.218	ksi
Tensile strength		0.0725	-	0.363	ksi
Compressive strength		0.0783	-	0.29	ksi
Elongation		20	-	80	% strain

Fatigue strength at 10^7 cycles	0.0435	-	0.16	ksi
Fracture toughness	0.0455	-	0.091	ksi.in^0.5
Mechanical loss coefficient (tan delta)	0.1	-	0.3	

Thermal properties

Glass temperature	170	-	215	°F
Maximum service temperature	242	-	278	°F
Minimum service temperature	-99.7	-	-9.67	°F
Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.0202	-	0.0277	BTU.ft/h.ft^2.F
Specific heat capacity	0.454	-	0.502	BTU/lb.°F
Thermal expansion coefficient	72.2	-	128	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Poor insulator				
Electrical resistivity	*	1e9	-	1e11	µohm.cm
Dielectric constant (relative permittivity)	*	6	-	8	
Dissipation factor (dielectric loss tangent)	*	0.02	-	0.05	
Dielectric strength (dielectric breakdown)	*	25.4	-	50.8	V/mil

Optical properties

Transparency	Opaque

Critical Materials Risk

High critical material risk?	No

Processability

Moldability	3	-	4	
Machinability	4			

Durability: water and aqueous solutions

Water (fresh)	Excellent
Water (salt)	Acceptable
Soils, acidic (peat)	Limited use
Soils, alkaline (clay)	Limited use
Wine	Excellent

Durability: acids

Acetic acid (10%)	Acceptable
Acetic acid (glacial)	Limited use
Citric acid (10%)	Acceptable
Hydrochloric acid (10%)	Acceptable

Hydrochloric acid (36%)	Unacceptable
Hydrofluoric acid (40%)	Unacceptable
Nitric acid (10%)	Acceptable
Nitric acid (70%)	Unacceptable
Phosphoric acid (10%)	Acceptable
Phosphoric acid (85%)	Unacceptable
Sulfuric acid (10%)	Acceptable
Sulfuric acid (70%)	Unacceptable

Durability: alkalis

Sodium hydroxide (10%)	Unacceptable
Sodium hydroxide (60%)	Unacceptable

Durability: fuels, oils and solvents

Amyl acetate	Acceptable
Benzene	Acceptable
Carbon tetrachloride	Acceptable
Chloroform	Acceptable
Crude oil	Acceptable
Diesel oil	Acceptable
Lubricating oil	Acceptable
Paraffin oil (kerosene)	Acceptable
Petrol (gasoline)	Acceptable
Silicone fluids	Acceptable
Toluene	Acceptable
Turpentine	Acceptable
Vegetable oils (general)	Acceptable
White spirit	Acceptable

Durability: alcohols, aldehydes, ketones

Acetaldehyde	Acceptable
Acetone	Acceptable
Ethyl alcohol (ethanol)	Acceptable
Ethylene glycol	Acceptable
Formaldehyde (40%)	Acceptable
Glycerol	Acceptable
Methyl alcohol (methanol)	Acceptable

Durability: halogens and gases

Chlorine gas (dry)	Unacceptable
Fluorine (gas)	Unacceptable

O2 (oxygen gas)	Unacceptable
Sulfur dioxide (gas)	Acceptable

Durability: built environments

Industrial atmosphere	Acceptable
Rural atmosphere	Excellent
Marine atmosphere	Acceptable
UV radiation (sunlight)	Good

Durability: flammability

Flammability	Self-extinguishing

Durability: thermal environments

Tolerance to cryogenic temperatures	Acceptable
Tolerance up to 150 C (302 F)	Acceptable
Tolerance up to 250 C (482 F)	Unacceptable
Tolerance up to 450 C (842 F)	Unacceptable
Tolerance up to 850 C (1562 F)	Unacceptable
Tolerance above 850 C (1562 F)	Unacceptable

Primary material production: energy, CO2 and water

Embodied energy, primary production	* 412	-	455	kcal/lb
CO2 footprint, primary production	* 0.181	-	0.2	lb/lb
Water usage	* 79.7	-	88.1	gal(US)/lb
Eco-indicator 99	127			millipoints/kg

Material processing: energy

Coarse machining energy (per unit wt removed)	* 56.9	-	62.8	kcal/lb
Fine machining energy (per unit wt removed)	* 105	-	117	kcal/lb
Grinding energy (per unit wt removed)	* 159	-	177	kcal/lb

Material processing: CO2 footprint

Coarse machining CO2 (per unit wt removed)	* 0.0394	-	0.0435	lb/lb
Fine machining CO2 (per unit wt removed)	* 0.073	-	0.0807	lb/lb
Grinding CO2 (per unit wt removed)	* 0.11	-	0.122	lb/lb

Material recycling: energy, CO2 and recycle fraction

Recycle	✗			
Recycle fraction in current supply	0.1			%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 2.14e3	-	2.31e3	kcal/lb

Combustion CO2	* 1.69	-	1.78	lb/lb
Landfill	✓			
Biodegrade	✓			
Toxicity rating	Non-toxic			
A renewable resource?	✓			

Environmental notes

Cork is a renewable resource. Its processing generates waste: contaminated water and inflammable cork dust, but these can be managed.

Supporting information

Design guidelines

The compressibility and great stability of cork, both in water and in oil, make it attractive for bottle stoppers, for gaskets and for packaging. It is easily cut and its fine cellular structure makes allows it to be carved to intricate shapes. Its vibration damping and thermal insulation qualities, together with its warm color and attractive texture give cork and products made from in (cork board, linoleum) a large market in floor, wall and ceiling coverings.

Technical notes

Cork is used for stoppers and bungs for bottles; floats; life-belts; walls; flooring; insulation; shoes; packaging; fancy goods; decoration; gaskets; road surfaces; linoleum; polishing; brake pads; vibration damping.

Typical uses

Corks, stoppers, bungs for bottles, floats, lifebelts, walls, flooring, insulation, shoes, packaging, fancy goods, decoration, gaskets, road surfaces, linoleum, polishing, brake pads, vibration damping.

Links

Reference

ProcessUniverse

Producers