Flexible Polymer Foam (VLD)

Description

Image

Caption

1. A sample of shock absorbing foam with a slowly disappearing hand imprint. © Chris Lefteri 2. Flexible foams are used for cushions, mattresses and packaging. © Sumed International UK

The material

Polymer foams are made by the controlled expansion and solidification of a liquid or melt through a blowing agent; physical, chemical or mechanical blowing agents are possible. The resulting cellular material has a lower density, stiffness and strength than the parent material, by an amount that depends on its relative density - the volume-fraction of solid in the foam. Flexible foams can be soft and compliant, the material of cushions, mattresses, and padded clothing. Most are made from polyurethane, although latex (natural rubber) and most other elastomers can be foamed.

Composition (summary)

Hydrocarbon

General properties

Density		0.999	-	2.18	lb/ft^3
Price	*	1.18	-	1.31	USD/lb
Date first used		1947			

Mechanical properties

Young's modulus		3.63e-5	-	1.45e-4	10^6 psi
Shear modulus		1.45e-5	-	7.25e-5	10^6 psi
Bulk modulus		3.63e-5	-	1.45e-4	10^6 psi
Poisson's ratio		0.23	-	0.3	
Yield strength (elastic limit)		0.00145	-	0.0174	ksi
Tensile strength		0.0348	-	0.123	ksi
Compressive strength		0.00145	-	0.0174	ksi
Elongation		10	-	135	% strain
Hardness - Vickers		0.001	-	0.012	HV
Fatigue strength at 10^7 cycles	*	0.0218	-	0.102	ksi
Fracture toughness	*	0.00455	-	0.0182	ksi.in^0.5
Mechanical loss coefficient (tan delta)	*	0.1	-	0.5	

Thermal properties

Melting point		233	-	350	°F
Glass temperature		-172	-	8.33	°F
Maximum service temperature		188	-	233	°F
Minimum service temperature		-99.7	-	-9.67	°F
Thermal conductor or insulator?		Good insulator			

Thermal conductivity	0.0208	-	0.0277	BTU.ft/h.ft^2.F
Specific heat capacity	0.418	-	0.54	BTU/lb.°F
Thermal expansion coefficient	66.7	-	122	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	1e20	-	1e23	µohm.cm
Dielectric constant (relative permittivity)	1.1	-	1.15	
Dissipation factor (dielectric loss tangent)	5e-4	-	0.003	
Dielectric strength (dielectric breakdown)	102	-	152	V/mil

Optical properties

Transparency	Opaque

Processability

Castability	3	-	5	
Moldability	1	-	4	
Machinability	3	-	4	
Weldability	1			

Eco properties

Embodied energy, primary production	* 1.12e4	-	1.24e4	kcal/lb
CO2 footprint, primary production	* 4.28	-	4.73	lb/lb
Recycle	✗			

Supporting information

Design guidelines

Flexible foams have characteristics that suit them for cushioning and packaging of delicate objects. They are shaped by injecting or pouring a mix of polymer, catalyst and foaming agent into a mold where the agent evolves gas, expanding the foam. Expanding in a cold mold gives a solid surface skin. Closed cell foams float in water; open cell foams absorb liquids and act as sponges.

Technical notes

The properties of foams depend, most directly, on the material of which they are made and on the relative density (the fraction of the foam that is solid). Most commercial foams have a relative density between 1% and 30%. To a lesser extent, the properties depend on the size and the shape of the cells. Low density, closed cell, foams have exceptional low thermal conductivity. Skinned rigid foams have good bending stiffness and strength of low weight.

Typical uses

Packaging, buoyancy, cushioning, sleeping mats, soft furnishings, artificial skin, sponges, carriers for inks and dyes.

Links

Reference

ProcessUniverse

Producers