Polyurethane

Description

Image

Caption

1. Close-up of the material's surface. © Chris Lefteri 2. Bike seats with polyurethane cores. © Chris Lefteri

The material

Think of polyurethanes and you think of the soft, the stretchy, materials and fabrics (Lycra or Spandex). Like PVC, polyurethanes have thermoplastic, elastomeric and thermosetting grades. They are easily foamed; some 40% of all PU is made into foam by mixing it with a blowing agent. The foams can be open- or closed-cell, microcellular or filter grades. They are the strongest of elastomers.

Composition (summary)

(CO-NH-R-NH-CO-O-R-O)n

General properties

Density		63.7	-	78	lb/ft^3
Price	*	1.88	-	2.07	USD/lb
Date first used		1941			

Mechanical properties

Young's modulus		2.9e-4	-	0.00435	10^6 psi
Shear modulus		1.02e-4	-	0.00116	10^6 psi
Bulk modulus		0.218	-	0.232	10^6 psi
Poisson's ratio		0.49	-	0.498	
Yield strength (elastic limit)		3.63	-	7.4	ksi
Tensile strength		3.63	-	7.4	ksi
Compressive strength		7.25	-	14.5	ksi
Elongation		380	-	720	% strain
Fatigue strength at 10^7 cycles	*	2.73	-	5.55	ksi
Fracture toughness		0.182	-	0.364	ksi.in^0.5
Mechanical loss coefficient (tan delta)	*	0.51	-	1.2	

Thermal properties

Glass temperature		-99.7	-	-9.67	°F
Maximum service temperature		152	-	188	°F
Minimum service temperature	*	-99.7	-	-9.67	°F
Thermal conductor or insulator?		Good insulator			
Thermal conductivity		0.162	-	0.173	BTU.ft/h.ft^2.F
Specific heat capacity		0.394	-	0.406	BTU/lb.°F
Thermal expansion coefficient		83.3	-	91.7	µstrain/°F

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Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	1e18	-	1e22	µohm.cm
Dielectric constant (relative permittivity)	5	-	9	
Dissipation factor (dielectric loss tangent)	0.003	-	0.009	
Dielectric strength (dielectric breakdown)	406	-	559	V/mil

Optical properties

Transparency	Translucent

Processability

Castability	4	-	5	
Moldability	4	-	5	
Machinability	2	-	3	
Weldability	1			

Eco properties

Embodied energy, primary production	*	8.96e3	-	9.91e3	kcal/lb
CO2 footprint, primary production	*	3.52	-	3.89	lb/lb
Recycle	✗				

Supporting information

Design guidelines

Urethanes have exceptional strength (up to 48 MPa) and abrasion resistance, low compression set and good fuel resistance. They have useful properties from -55 C to 90 C

Technical notes

Urethane elastomers (elPU) are co-polymers of diisocyanate and polyester.

Typical uses

Cushioning; packaging; shoe soles; tires; fuel hoses; gears; bearings; car bumpers; adhesives; fabric-coating.

Links

Reference

ProcessUniverse

Producers